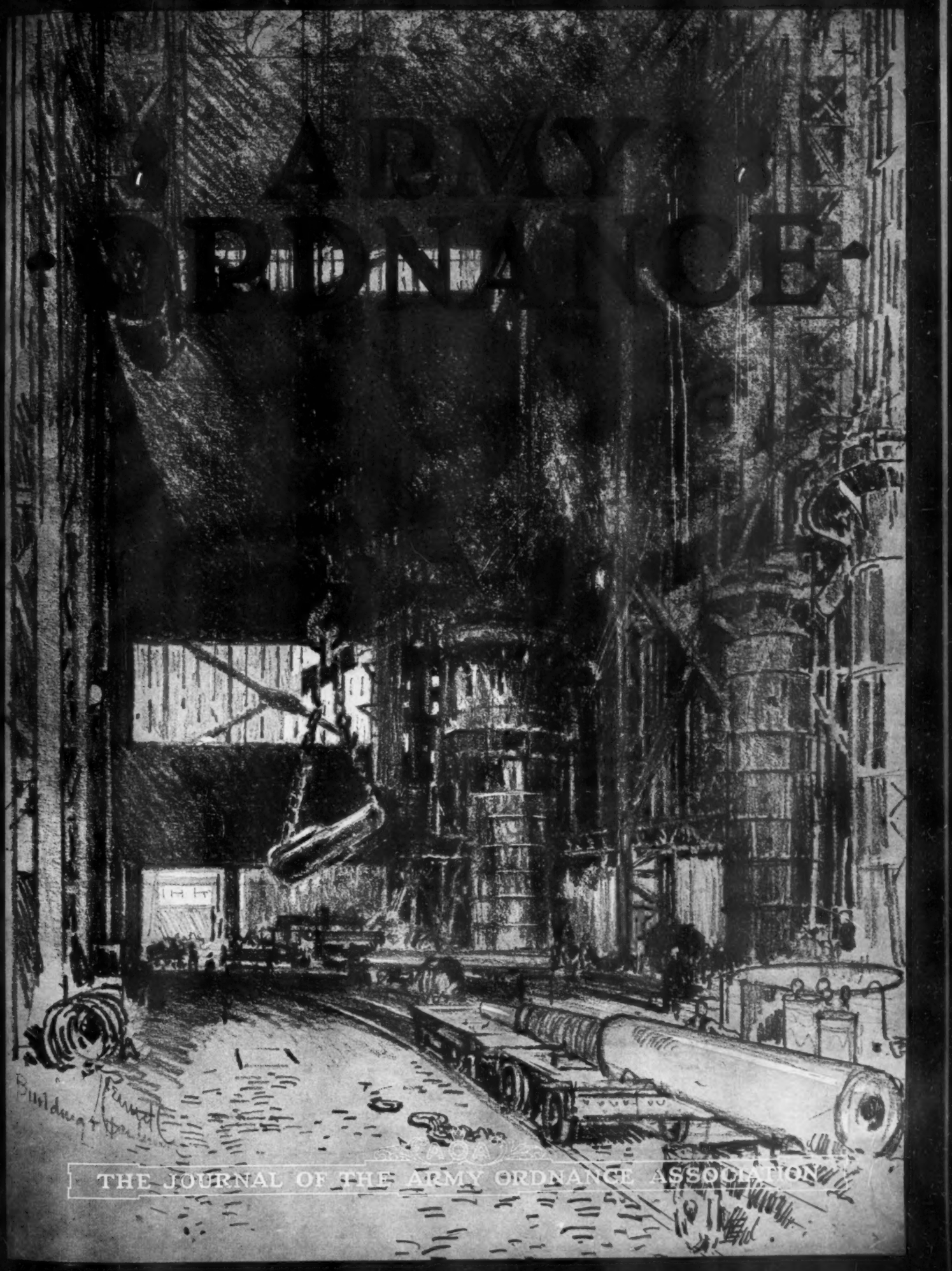
ARMY ORDNANCE
THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

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NEW YORK CHICAGO ST. LOUIS

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FOR
ARMY AND NAVY REQUIREMENTS

ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace!

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"No great nation in the world, knowing that America has prepared itself for defense, will ever venture to attack it. It is the best insurance against aggression and it is costing the people of the United States almost nothing in its preparation."
Charles B. Robbins, *Former Assistant Secretary of War.*

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our Nation's strongest guarantee of peace.

THE Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

THE Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace Insurance" in this form is the foremost aim of the Army Ordnance Association.

THE Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American Scientists, Inventors, Engineers and Manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged.

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Maj. Gen. C. C. Williams, Chief of Ordnance, U. S. Army

Leader and Guiding Spirit of Phenomenal Ordnance Progress During and Since the World War.

CALLED from France to assume the arduous task of Army munitionment in 1918, General Williams continues as Chief of Ordnance to instill into the organization of which he is head and the huge industrial forces coöperating with it an ideal of exceptional efficiency. His leadership in the World War holds high place in the record of those days. His service since is no less remarkable. Under his guidance every post-war ordnance problem has been pressed toward satisfactory solution. While the war of words over bombs versus battleships was waging he spurred the Department to the design and production of bombs of the highest efficiency; then, as the problem of defense against aircraft arose, he led his associates in the design and manufacture of our superb antiaircraft artillery. When mechanization—of which he writes in this issue—came upon the scene, the Department under his direction established a record of achievement which points the way to an early and satisfactory solution. During his régime new and better weapons of all calibers and their ammunition have been perfected. In the broad field of ordnance coöperation with American industry, satisfaction to the using services of the Army, and esprit in his own organization are the bases of every major policy and defense activity under his control.

ARMY ORDNANCE

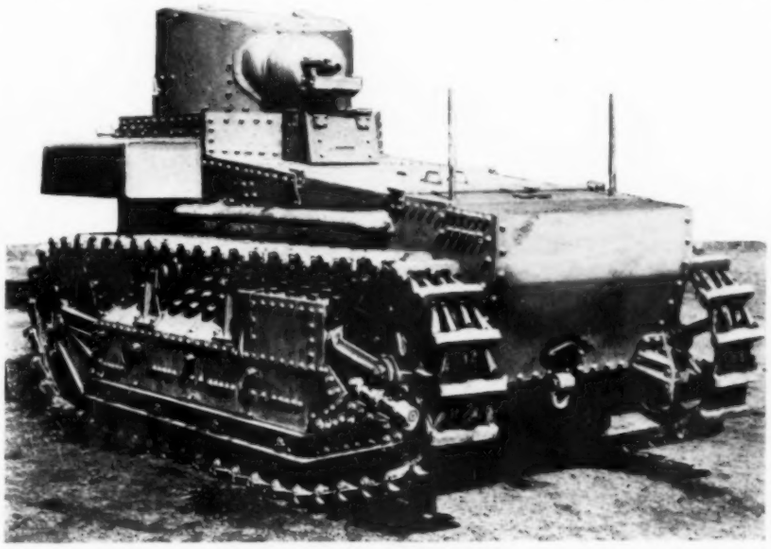
VOL. IX MARCH-APRIL, 1929 No. 53

Mechanization

The New Era of the Armored Fighting Vehicle

By C. C. Williams*

THIS article does not pretend to present any new thought or any new data on the subject of mechanization. It is rather a review of some of the things which have been said or done on the subject in the nearby past. The subject of mechanization should make a strong appeal to the members of the Army Ordnance Association and to the readers of this Journal. By mechanization is meant those means and methods by which the tremendous mechanical developments of the age are brought to the assistance of our soldiers on the battlefield. For example, the skill of our automotive engineers and the unequalled development of our automotive industry should provide for our soldiers tanks, armored cars, armored cargo carriers, and other armored vehicles of the best types and designs and in any needed quantities.



The American Light Tank.

Since the World War great strides have been made in the design and construction of tanks and self-propelled track-laying fighting vehicles of all sorts. The developments made in particular types have led quite naturally to a study as to how such units may be employed from the tactical standpoint.

During the war the infantry and the tanks moved forward in the attack at about the same pace. By such a system the infantry suffered, as the ground was usually not such as to permit of the foot soldier using covered approaches, and not such as to permit the tank to use its speed. It is quite true that the tanks of the World War were very crude and slow, but even so, their rate of advance could have been greater than that of the infantry had not the tactics of the day been to tie the two forces together. At this time when we have tanks and other armored vehicles possessing a speed as high as 20 miles an hour, it becomes increasingly obvious that the tactics for the employment of armored vehicles are subject to radical revision.

The mechanical dependability of vehicles to be employed in a mechanized force also has been enormously improved since the World War. The light tank, for instance, recently produced by the Department has operated a distance of 2,000 miles at high speeds without major overhaul. This is to be compared to the wartime tank which covered from 50 to 60 miles between major overhauls. A tank will travel a distance of approximately 50 miles during a major engagement.

Such performance specifications of the modern tanks at once serve to divorce the infantry and the tanks in battle operations. The infantryman advancing unprotected, in order to survive modern day machine gun fire, must make use of the covered approaches afforded by the terrain in his attempt to escape hostile fire. The tank or other armored vehicle, on the other hand, must depend upon its armor plate protection and speed for its effectiveness and safety and, therefore, should select primarily for its field of operation the best terrain available within the battle area. The objective of the tanks and the infantry may be the same, but it will often be necessary to employ them on different sections of the battlefield. It is evident that the infantry must, therefore, be organized into a unit of one kind, and the armored fighting vehicles into a unit of a totally different character. With vehicles moving at speeds of from 15 to 20 miles an hour in their battle operations, it is apparent that the infantry as such, will not be able to keep up with the movement. The tanks will, therefore, be left without reconnaissance for their movement to the front or the flanks and will be left without covering fire.

It should be increasingly evident, therefore, that a mechanized force should contain within itself all the necessary elements of high speed reconnaissance, high speed attack, high speed vehicles to afford supporting fire for the attack wave, and high speed armored vehicles to carry its

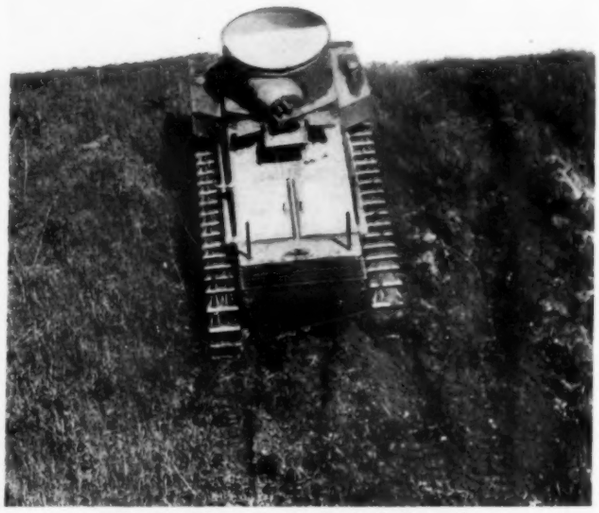
*Major General, Chief of Ordnance, U. S. Army.

The Light Tank Chassis.

machine gunners and automatic riflemen forward to occupy and hold the objective which has been reached.

HAVING stated these broad principles it is now of interest to examine the vehicles which have been developed, and which should be welded together into an integral and well organized mechanized force. The first and controlling thought in all items of Ordnance equipment for the Army should be, and is, their availability and possibility of procurement in time of an emergency. The ideal would be to employ nothing but vehicles to be found in large commercial production, and with this thought in view intimate contact is maintained with the industry as developments are made. There is no commercial demand, however, for high speed track-laying vehicles, and more especially there is no demand for fighting tanks, for self-propelled gun mounts, for armored cars, for armored infantry carriers, and the several other vehicles which go to make up a mechanized force. The Ordnance Department, therefore, has been forced to develop vehicles of its own design.

In an effort to lessen the production, maintenance and supply problems in time of an emergency, we have developed a basic all-purpose track-laying chassis of great power, and consequently of high speed, which may be used for the wide variety of vehicles to be found in a properly equipped mechanized force. This vehicle, known as the light tank chassis, T1 E1, is adapted to carry interchangeably, with but few modifications, a tank house with its armament, a 75-mm. gun with armored shield, a cargo



The Light Tank in Typical Operation.

body for the supply of ammunition, spare parts, gasoline and oil, etc., wire reels for communications, engineer bridge equipment, the chemical smoke-producing mortar, searchlight equipment, antiaircraft machine gun mounts, etc. The problem will thus resolve itself largely into the production and maintenance of one chassis for this wide variety of purposes, rather than, as in the last war, of a large number of different vehicles. The illustrations show the light tank chassis alone, and the chassis with the tank house mounted in the one case, and the cargo body in the other. The great advantage of this design scarcely requires any further comment to those in commercial industry.

Funds have not been available as yet to develop a suitable armored infantry carrier, but as the need for such a vehicle is so very real, the Ordnance Department has high hopes of seeing a successful consummation of this development within the relatively near future. It is indeed inconceivable that the unprotected soldier will be able to advance against emplaced machine guns with even their present rate of fire of 600 rounds per minute. The vehicle we have

The Light Tank Climbing a 40° Slope.

in mind will be used, after the tanks and the accompanying artillery have overcome the immediate enemy resistance, to carry forward a small machine gun squad, with ample ammunition, for the purpose of occupying the objective gained and holding it against counter-attack. By the use of a large number of these little transports, a line may be quickly occupied by a strong force of machine guns, the crews for which have been carried forward behind *armor plate*. The battle losses in men will thus be greatly reduced. The infantry carrier will operate at speeds as great as that possessed by the light tanks, and will be armored to resist machine gun and rifle fire. It will be as light in weight as is consistent with dependable design.

The illustration of the 75-mm. self-propelled gun mount with its shield, shows the simplicity of mounting this gun on the chassis. The speed is that of the light tanks, in order that the mechanized force may move as a unit, and so that supporting fire may always be at hand in the attack. The ammunition or cargo carrier shown in the illustration assures an ammunition supply for these weapons.

The Light Tank During a Test Run.

The Light Tank During Trial Tests.

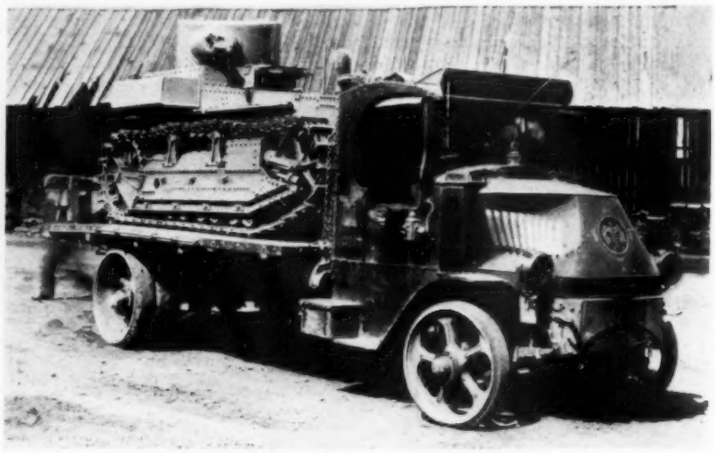
A mechanized force moving at such a high rate of speed, as compared with the rate of movement of an army the elements of which are on foot, introduces great problems in the control of the force by the commander. Wire reels of large capacity, mounted on the light tank chassis, will permit of the rapid laying of wire. In addition, a command tank and a radio tank must be developed employing the light tank chassis as a basis. The problem of control by the commander is indeed a most perplexing one, and after a mechanized force is properly supplied with modern equipment the means and technique of control can be worked out only by actual maneuvers under variously assumed battle situations.

During tests this past summer the new light tanks completed a road march of 145 miles in two days, at an average speed of 10.5 miles an hour. However, in moving the track machines comprising the mechanized force over great distances on the road, it is, of course, far more economical to carry the various vehicles on wheeled trucks or trailers which are readily procurable from the commercial industry. In the design of all units of the mechanized force the weight, in each instance, should be held, therefore, to that which may be transported upon a heavy duty commercial truck. Having arrived at its immediate theatre of operations, the track vehicles will leave their wheeled transport and continue on their battle mission. Should this mission require several days in its development, further supplies of gasoline and oil will be brought by trucks, operating on the roads, to a "truck head." The track cargo carriers of the force will work from this truck head to the combat vehicles of the force for their refueling and maintenance.

ONE of the problems confronting the armies of the world for solution is protection on the march from low-flying enemy airplanes which will employ both their machine guns and small bombs. While the vulnerability of an

The Light Tank Negotiating a Stream.

armored force to this type of attack is clearly not as great as that of a horse-drawn column, the fact remains that anti-aircraft protection must be afforded by units of the force itself. The light tank chassis, mounting a multiple machine gun antiaircraft mount with enormous volume of fire, is the apparent answer to such attack. The guns are capable of going into immediate action and will serve to keep enemy planes at altitudes which make accurate bombing against a moving body most difficult. Upon the approach of hostile planes the mechanized force, being composed of track-laying vehicles only, can leave the road and scatter. A widely dispersed target will thus be presented to the attacking planes. The multiple machine gun mount is also adapted for use against ground targets as well as against aircraft.



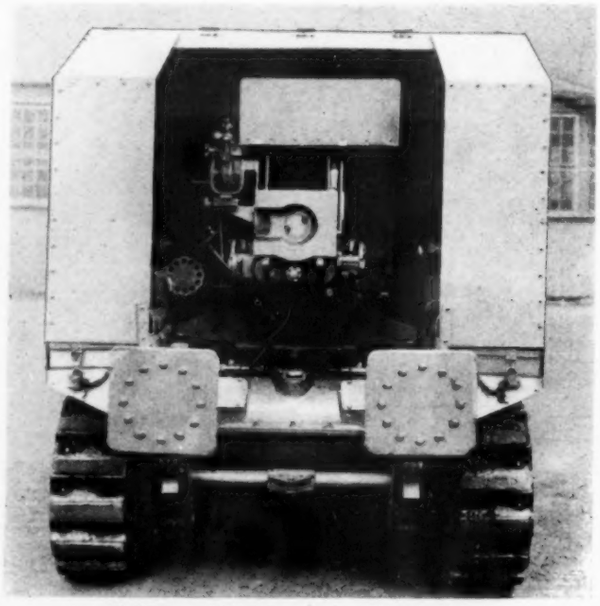
The Light Tank Carried on a Mack Truck.

Unit	Men	Arms	Weight of fire (lbs.—min.)	Fire—min—man—engaged (lbs.—min—man)
Troops, Cavalry	114	103 rifles, 7 pistols, 4 auto. rif.	44	0.39
Infantry Rifle Co.	256	235 rifles, 16 auto. rif.	105	0.41
Machine Gun Co.	178	16-.30 cal.	1.7	1.1
Battery 75-mm. Guns	199	4-75-mm.	520	2.6
Light Tank Co.	112	24-37-mm, 24-.30 cal. machine	748	6.7

In the last analysis, armies are organized for the primary purpose of delivering a maximum of fire power per man engaged, just as industry is organized with a view to securing the maximum of production for each man engaged therein. The thought impelling the organization of a mechanized force is to increase the fire power or "output" of the individual engaged in battle. In this connection the table given above offers interesting data, and it is believed very clearly brings out the real purpose of mechanization.

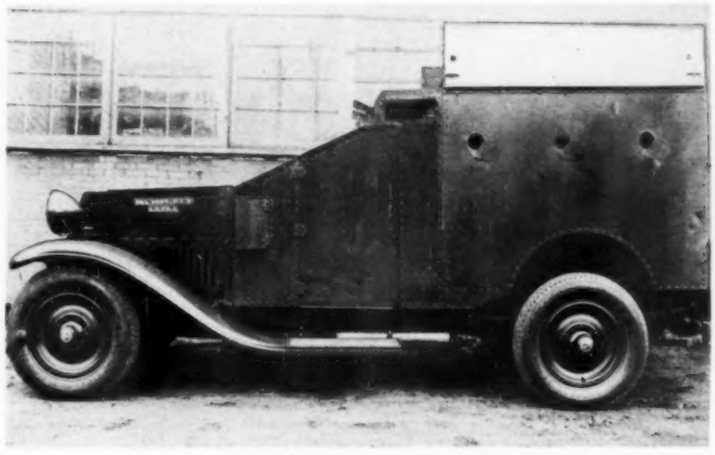
This table, of course, does not take into account the great morale-shattering effect produced by a vehicle, which is impervious to the machine gun, rushing at high speed toward the enemy troops. The tank does not heed the machine gun which, in the past, has created such enormous losses among the unprotected foot soldier, and broken up the attack. It will indeed require troops of the highest training and greatest courage to stand by their positions in the face of such an assault. The mechanized force will normally launch its attack in the nature of a surprise and, with its fast-moving vehicles, will be very difficult for field artillery guns to register upon. The attack will be launched with great momentum, and artillery supporting fire from the self-propelled gun mounts will be rapidly echeloned forward with the attacking tank wave. Such fire will largely neutralize the enemy's artillery fire within the immediate zone of the attack, and will support the line gained by the tanks and occupied by the machine gunners, which have been carried forward in the infantry machine gun carriers, against counter attack. The number of men occupied in such an operation with the mechanized force will be far less than in the normal infantry attack of the World War, and these men will be protected by the speed and armor of their vehicles. Their losses consequently will be very materially less, and their objectives will be gained in far less time.

Reconnaissance and seeking out of the enemy's position will be had by airplane observation and scouting, by armored cars confined necessarily to improved roads, and by tanks. The airplanes engaged will not be a component part of the mechanized force but will be attached thereto for the purpose of any individual operation. The armored cars of the mechanized force which are shown in the illustration, have armor-plate hulls mounted on high speed La Salle passenger car chassis, and as such present no difficult problem of production in time of war. Their operation, in fact the operation of any wheeled vehicle for army use over all kinds of terrain and in all kinds of weather, will be limited in the main to improved roads. They will scout normally far out in advance of the mechanized force, and will explore the highways to the front. The



Self-Propelled Mount for 75-mm. Gun.

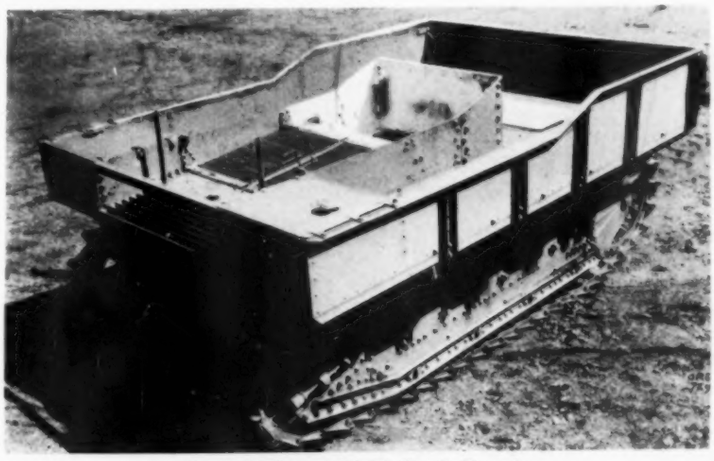
combat vehicles within a mechanized force will be entirely of the track-laying variety. The wheeled vehicles will, of course, leave the roads when the ground is hard and dry, but unfortunately the necessity of operation in time of war is not limited to fair weather and dry ground. The track-laying vehicle represents the extreme limit of man-made machine in negotiating soft ground, and the mechanized force will properly accept no vehicle within its organization which does not fully measure up to the requirement that it must represent the limit of the art in cross-country mobility. Wheeled vehicles are, of course, much more economical of operation and much more efficient while operating on hard roads than are track-laying vehicles. The sphere of operations of the mechanized force is, however, off the roads, and as such its combat vehicles must and will be entirely of the track-laying variety. A glance at the illustrations showing the light tank negotiating typical terrain of mud and grades, only serves to bear out the thought as here presented of the necessity for employing combat vehicles of the track-laying type within the mechanized force.



The Medium Armored Car.

Hard surface roads have been built in great quantity in this country for the operation of wheeled vehicles. The great sale of automobiles, busses and trucks in this country within the past few years has been made possible through the laying of hard surface roads. The track-laying tractor industry of the country has been successfully developed in producing vehicles which are not limited to improved roads for their operation. These tractors operate over terrain which is not passable by the round wheeled vehicles.

The thought at once presents itself of a developing a vehicle which is adapted to operate on the roads on its wheels, and by the addition of a track over and around all of the wheels, to operate as a track-laying vehicle off the roads. Much effort has been spent both in this country and abroad to evolve such a machine. The ideal as represented in such a combination is indeed an alluring one. Of the many different types built, the photograph showing Mr. Walter Christie's combined wheel and track-laying vehicle represents one of promise. Further development of tactics may prove the necessity for the incorporation of such an armored car in the mechanized force.



Cargo Body on Light Tank Chassis.

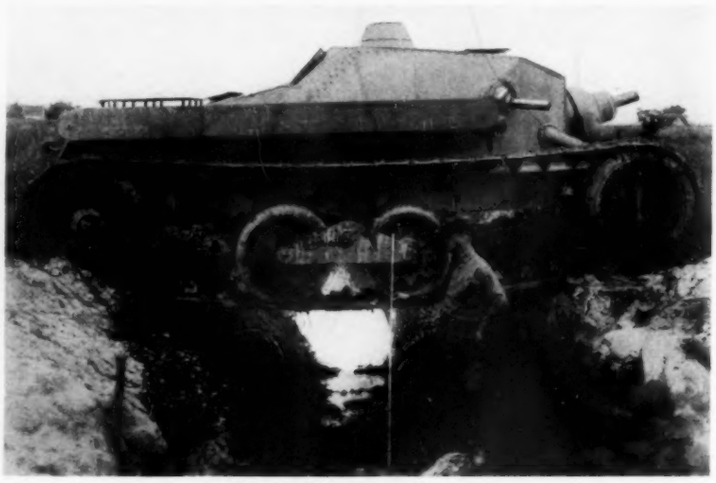
An attractive combination for reconnaissance well to the front of the mechanized force is presented by using a commercial truck to transport the light tank. An illustration shows the light tank on a Mack truck. Upon arriving at a position where more detailed reconnaissance is required, it is but a matter of two or three minutes for the tank to run down off the truck and proceed at high speed on its mission of reconnaissance. Upon returning to its truck it can very quickly run onto the truck body under its own power and the reconnaissance can further be carried forward over the road. By such a combination we are using a truck readily procurable from the commercial industry in quantity, and we are using a tank which, while not of commercial production, is a necessary component of our fighting forces and as such must be provided.

In further increasing the fire power of the mechanized force, the weapons with which the soldier will be armed will be the machine gun and the automatic rifle. The single shot shoulder rifle will not be in evidence. The tanks will be equipped with semiautomatic cannon. The fire power of the force will be a maximum and will express within itself the limit of the art.

In advance and in rear guard actions the mechanized force, due to its great mobility and its great fire power, will represent a tremendous advance over World War days. In the advance guard it will assure a practically uninterrupted advance of the main body until such time as the enemy is encountered in force. In the rear guard action it can delay the enemy's advance and insure the uninterrupted and unharassed retreat of its main body. In turning movements, and in enveloping the enemy's flanks, its great speed will make it a force of maximum usefulness.

Owing to the lack of mobility, or rather the inability—due to its weight—to be transported on commercial trucks, the medium 15-ton tank may not be considered as an integral part of the mechanized force. However, there will be occasions when heavy resistance is expected to be encountered, when medium tanks will be attached to the mechanized

force in order to lend greater striking power. The medium tanks carry heavier guns, 3-pdr., than do the light tanks, 37-mm. gun, and carry more men, machine guns and ammunition. Their speed is such, however, that they will be able to maintain the rate of advance of the light tanks in the battle. Their armor will resist bullets of greater caliber than will that of the light tank, and as such they will be used to overcome strong points of resistance.



The Christie Armored Tank.

Another weapon of the mechanized force which will prove of great value in particular instances is the chemical mortar mounted on the light tank chassis. It will fire smoke shell to screen the operation from the enemy gunners. Obviously smoke must be used correctly as otherwise it will blind its own forces—control will be destroyed and confusion will result.

THERE is no thought that a mechanized force will revolutionize warfare. It most certainly will not. It must be considered as but another weapon of immense power in the hands of the commander. Changes in the tactics of warfare must perforce be made to insure correct incorporation of the force within the Army. When such a force is finally assembled with modern equipment, and when the correct tactics are worked out for its employment the full value of the force will, I am quite confident, be measured and understood. Admiral Mahan has very aptly stated:

"The student will observe that changes of tactics have not only taken place *after* changes in weapons, which necessarily is the case, but that the interval between such changes has been unduly long. This doubtless arises from the fact that an improvement of weapons is due to the energy of one or two men, while changes in tactics have to overcome the inertia of a conservative class; but it is a great evil. It can be remedied only by a candid recognition of each change."

We must not permit ourselves to measure the value of tanks by their performance in the World War any more than we must judge the automobile or the bus of 1929 by those of 1916. While the tank has not improved as greatly as has the commercial motor car, due to lack of funds for manufacture and development, it may conservatively be said that its performance is at least 400 per cent better in both speed and dependability. Even with World War tanks the casualties of the tank corps were the lowest in percentage of men killed to total casualties in all other arms. Thus the value of even those very crude machines is apparent in conserving the man power of the country for other effort in the successful prosecution of a war.

In his most excellent book entitled "On Future Warfare" by Col. J. F. C. Fuller, C. B. E., D. S. O., the author states:

"Economy in man power, both fighting and manufacturing, is in itself an enormous economy in money; nevertheless, I will now take a more concrete case. During the War, on an average a shell costs £5 and a tank £5,000; consequently the cost of one tank was equivalent to the cost of 1,000 shells. A shell once fired is totally expended; a tank, accepting a very conservative reckoning, fights four engagements before being wrecked. Therefore, the cost of one tank is approximately the equivalent of 250 shell; consequently had the cost of the 4,283,500 shells fired in the preliminary bombardment of the third battle of Ypres been spent on tanks 17,134 machines could have been produced. At the battle of Amiens, August 8, 1918, which Ludendorff christened 'The black day of the German Army' only 415 of these machines were used and with decisive results."

In time of peace no country can afford to keep a military establishment equal to that which it invariably acquires in the course of a war of any duration. It can afford, however, to keep a small well-equipped force around which adequate expansion along sound organizational lines may be made in time of an emergency. Thus, a small mechanized force equipped with the most modern vehicles and guns should be a possibility within our Army. It would serve as a laboratory for both the development of machines and tactics. In the development and manufacture of this small number of vehicles, the drawings would be made and experience would be had in the manufacture of the equipment. Manufacturing processes, in conjunction with the design, would be simplified, and the best procedure for emergency production would be evolved. Mass production would be reached in a far less time with such experience and with such completed designs at hand than if we wait until the outbreak of an emergency before the designs and the manufacturing processes are settled upon. The tactics of such a force would have been worked out, and would be immediately available for imparting to the new components of the Army which would be taken in upon any great mobilization.

THE automotive art is advancing by leaps and bounds, and the industry numbers among its personnel some of the greatest engineers in the world. Its product is ever increasing in excellence, and yet this fact should in no way deter us from entering into the procurement of the necessary vehicles for a small well-organized and well-equipped mechanized force. We cannot wait until the ideal is reached. As long as man is possessed with the inventive genius with

which the human race is endowed, the ideal will never be reached. So we should make a start; the developments and logical improvements will follow.

A natural inquiry in this subject of mechanization is, "What has the Ordnance Department done to coöperate with the great automotive industry of this country in the solution of its automotive problems?" A committee appointed by the Society of Automotive Engineers in 1919 has held biennial meetings, usually at some great plant of the industry, with the officers and engineers of the Ordnance Department who are carrying forward our automotive development. To this committee are submitted for criticism and suggestion all of our designs before such are put into manufacture. Grateful appreciation to these gentlemen is here fully accorded. The membership of the committee given shows the high quality of engineering talent which the Society has so generously placed at our disposal: Col. Alfred F. Mausry, Ord. Res., Chairman, Vice-President-Chief Engineer, Mack Truck Co.; Col. Wm. G. Wall, Ord., Res., Consulting Engineer, President, Society of Automotive Engineers; Col. H. W. Alden, Ord. Res., Chairman of the Board, Timken-Detroit Axle Co.; Mr. B. B. Bachman, Chief Engineer, Autocar Company; Mr. W. L. Batt, President, S. K. F. Industries; Mr. C. F. Clarkson, General Manager, Society of Automotive Engineers; Mr. George A. Green (Ex-Colonel British Tank Corps), Chief Engineer, General Motors Corporation; Mr. A. W. Herrington, Manager, Eastern Div., Coleman Motor Truck Company; Mr. Pliny E. Holt, Vice-President, Caterpillar Tractor Company; Mr. C. F. Kettering, Vice-President, General Motors Corporation; Mr. Dent Parrett, Consulting Engineer, Chicago, Illinois; Mr. D. G. Roos, Chief Engineer, Studebaker Corporation; Mr. G. A. Round, Engineer, Vacuum Oil Company; Col. William Turnbull, Ord. Res., Chief Engineer, Caterpillar Tractor Company.

DURING the past summer the Secretary of War caused the assembly of a small force of all arms at Fort Leonard Wood, Md. This force was equipped with motor transportation and tanks. Unfortunately the equipment was largely of war-time design which precluded, in large part, obtaining a correct picture of the capabilities of such a force had it been equipped with modern vehicles. However, many valuable lessons were learned. It was a start in the right direction, and when funds are available for the supply of modern equipment, the full possibilities of such a force will be recognized.

I am hopeful that this article will have interested those members of the Army Ordnance Association and other readers who have had the patience to read it. If it has stimulated any reader's imagination to the point of offering a suggestion for improvement please send such suggestion to the Editor of ARMY ORDNANCE as early as practicable. Also any discussion of the matters which I have undertaken to describe in this article will be gladly received.

Joint Action of the Army and Navy

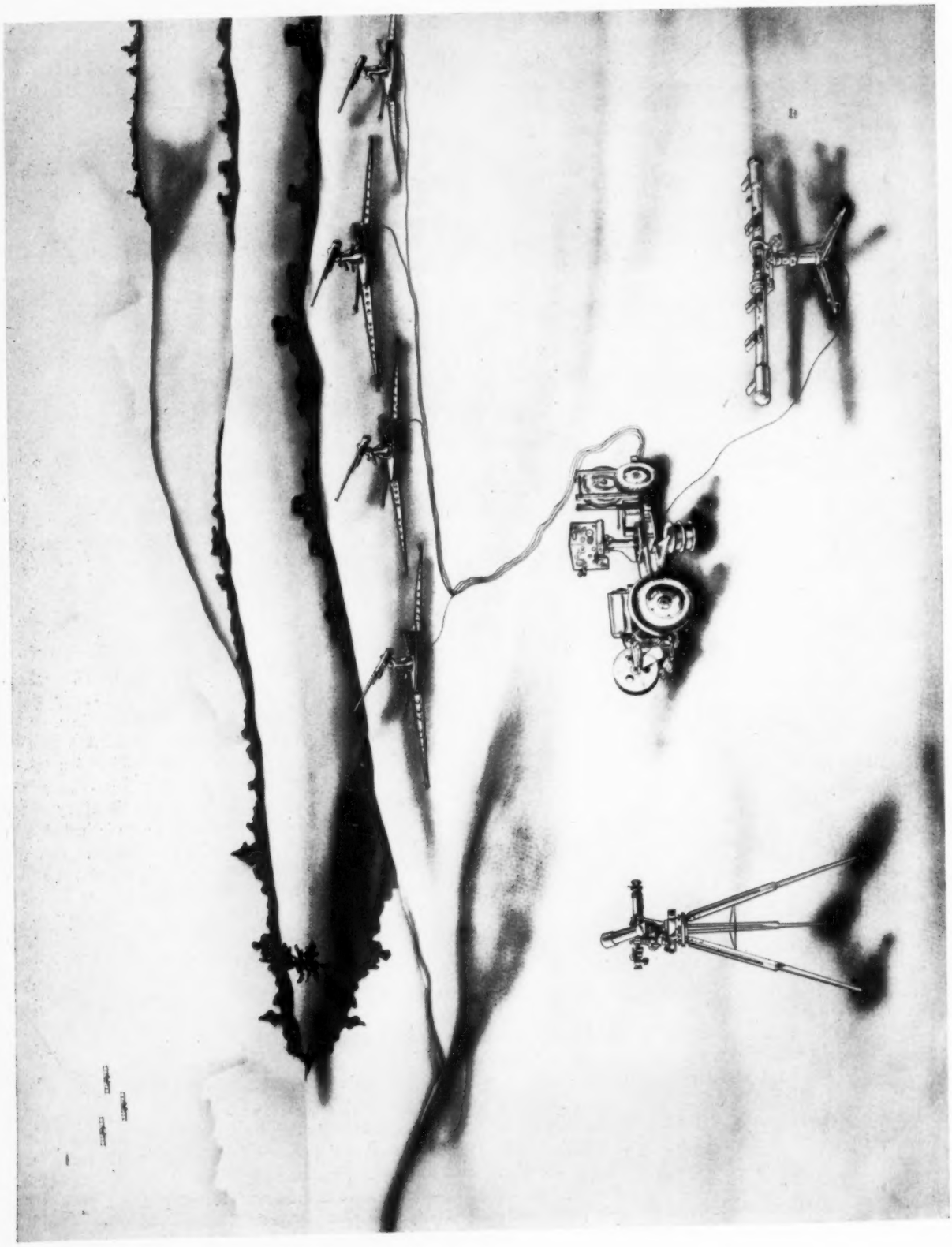
THE Joint Army and Navy Board for the past two years has been preparing and issuing installments of a publication containing policies and instructions on subjects of interest to both services. This publication is entitled "Joint Action of the Army and the Navy." The object in view can best be explained by quoting the following Foreword which was made effective by the signatures of the Secretaries of War and Navy on April 23, 1927: "1. It is vital to success in war that the Army and the Navy so coördinate their actions as to produce the most effective mutual support. To accomplish this it is essential that both services have a common, definite understanding of their respective functions in national defense and of the approved methods for attaining coördination in operations. 2. The aim of this publication is to assemble in one volume all joint policies, agreements, or instructions which have been approved by the War and Navy Departments, with a view to securing effective coördination. It is divided into two parts: Part I.—Policies to govern joint Army and Navy action; Part II.—Minor policies, agreements, and joint instructions which by providing effective organization and agencies for coördination, and by enunciating standard practice, promote harmonious joint action. 3. It is the intention to issue additional chapters to this publication covering the contents of Part II as soon as they can be prepared. The loose leaf form is adopted to permit this expansion and to facilitate revision of sections as may be found advisable."

Recently the Joint Board has agreed upon the contents of a chapter which it is felt represents a notable step in the agreements between the two Departments. This, Chapter V of "Joint Action of the Army and the Navy," deals primarily with the defense of our coastal frontiers.

Chapter V is based on Chapter IV of "Joint Action of the Army and the Navy" which gives consideration to the functions of the Army and the Navy in joint operations and enumerates the tasks of the Army and the Navy under the several types of joint operations. There is included in Chapter IV sections on coast defense, coördination of the Army and the Navy forces in coast defense, and a statement as to the necessity for joint organization in coast defense.

Chapter V has been written to develop more specifically the part played by both the Army and the Navy in coast defense. In its preparation, Army and Navy officers have conferred freely in the endeavor to set forth in the chapter a consolidated idea of the types and methods of probable naval attack against our frontiers and proper coördinated employment of the means to forestall or to defeat these attacks.

Chapter V therefore contains a discussion of possible enemy operations, both minor and major, to be expected against our coastal frontiers and cites the requirements and means, both Army and Navy, which it is desirable to have available to meet the different forms of attack by defining and explaining the organizations of the Army and the Navy which control seacoast defense forces. The endeavor has been made to present a picture to Army and Navy officers engaged in planning so that each service will understand the part to be played by the other service.



Schematic Drawing of the Principal Elements of the Mobile Antiaircraft Battery in Firing Position.

The 3-inch Mount in Towing Position Behind 4-wheel Drive Truck.

Modern Antiaircraft

A Description of the New Mobile 3-inch Battery

By G. M. Wells*

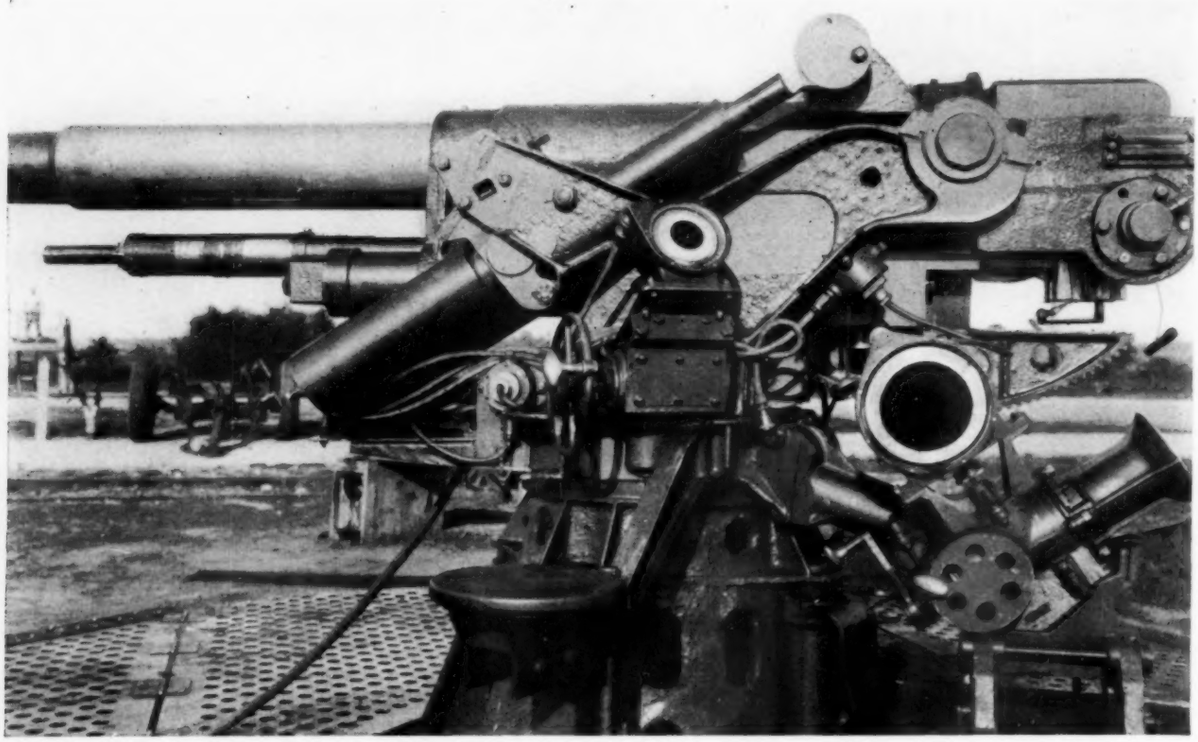
THE 3-inch gun is generally regarded by our services as the backbone of our antiaircraft defense against bombing planes. This feeling is shared by the prineipal European countries where guns of approximately the same caliber have received the greatest attention in post-war development. It is not intended to convey the impression that the 3-inch weapon is all that is needed; on the contrary a very real field exists for cannon of greater caliber for use at ranges beyond the reach of the lighter weapon. The weight of the larger caliber guns restricts their use to fixed defenses, and the lower rate of fire and greater difficulty in handling make them unsuitable for use against rapidly moving close-in targets. The 3-inch gun may be mounted on a fixed carriage for use in defense of permanent fortifieations, or on a carriage possessing a high degree of mobility for use in the field.

During a war great impetus is given to the development and improvement of all matériel of warfare, and in this respect the World War was a conspicuous example. No antiaircraft artillery of any consequence had been built prior to that time. The advent and rapid development of the airplane made imperative the development of defensive ground weapons. During the first part of the war field guns were blocked up to give high-angle fire and improvised mountings were used by both sides. In almost every case divisional weapons were used for this purpose. Thus we see the 3-inch caliber first adopted as a matter of expedieney, to prove itself later a most satisfactory all-purpose weapon. New antiaireraft artillery was designed and put into production as rapidly as possible so that toward the end of the war better types were available.

It was at once apparent that the difficulties in the way of providing suitable antiaireraft guns and carriages were to be encountered to a still greater degree in the production of adequate fire-control matériel. There was no background of experience to help in this emergency. A target moving at 100 miles per hour in three dimensions was a problem entirely beyond the possibility of adapting existing matériel and methods. Great efforts were made to devise a suitable fire-control system but the early systems were so complicated and so slow in operation that the data were more or less useless when received at the guns. Most of the early schemes depended on the use of manual plotting systems, reference charts and other methods derived from the field artillery and totally inadequate for this new purpose. During the latter part of the war semiautomatic computing machines were developed which considerably increased the efficieney of antiaircraft fire. These machines computed the vertieal and lateral deflections, the amount the gun must be laid in advance of the target's present position in order to allow for its travel

A Battery of 3-inch Antiaircraft Mobile Guns in Action.
Rate of fire for the battery 100 rounds per minute. Note long out-riggers in foreground.

*Chief, Antiaircraft Section, Artillery Division, Office of the Chief of Ordnance, Washington, D. C. Captain, Ordnance Department, U. S. Army.



Left-side View of 3-inch Antiaircraft Carriage Showing Automatic Fuze Setter and Azimuth and Fuze Data Receivers.

during the time of flight, and the fuze range or time of fuze burning.

During the period of the war the Ordnance Department was hastening the construction of a large number of 3-inch antiaircraft guns of more powerful type than had ever been used before. When the Armistice came many units had been completed and they still form the principal antiaircraft weapons in the hands of our troops. The guns were mounted on both fixed and mobile carriages. We may dismiss the fixed carriage with the statement that it is still regarded as basically satisfactory for the purpose. Minor changes have been made to improve the functioning and, as modified, this weapon is the present standard for manufacture.

THE war-time mobile weapon, the 3-inch auto trailer mount, M 1918, is inherently unsatisfactory in the light of our present requirements in the following respects: It is unstable and therefore unsuitable for director firing; the muzzle velocity of 2400 ft. per second is insufficient for fire against a modern high speed airplane; it has very poor cross-country mobility and its speed on improved roads is strictly limited. It is easy to appreciate that the defects enumerated cannot be corrected by modifying the present carriage.

3-inch Antiaircraft Gun with Removable Liner Partially Withdrawn from Gun Tube.

The defects and limitations just enumerated were recognized soon after the war and a development program inaugurated. Early efforts were devoted to attempts at modification of the 1918 carriages. Thus, the M 1923 E mobile carriage consisted of the M 1918 auto trailer chassis with certain improvements in levelling and in the recoil system and an improved outrigger arrangement giving greater stability. Several of the new features were quite successful but the carriage was still sadly wanting in mobility.

In 1925 and each succeeding year thereafter antiaircraft firing tests have been conducted under a joint Coast Artillery, Air Corps and Ordnance program. In the first test, which was held at Fort Tilden in 1925, the war-time antiaircraft artillery and fire control then in the hands of the service were used. A sufficiently large number of rounds were fired to demonstrate conclusively how inadequate this war-time matériel was in combatting modern high speed aircraft. In the short period since 1925 new and radically different guns, carriages and fire-control instruments have been designed and constructed, and have demonstrated in three

The Standard Antiaircraft Director.

years of firing at Aberdeen Proving Ground their almost infinite superiority when compared with the war-time weapons. This new matériel has been standardized and a limited rearmament program for the Regular Army inaugurated. The new 3-inch mobile matériel is probably the most important of the new developments because of its all-round utility. It may be used in fixed defenses where its stability and rate of fire are equal to the best type of fixed mount, or in the field where a high degree of mobility is added to the desirable characteristics just mentioned. The succeeding paragraphs will be devoted to a description of the several units included in a complete battery installation of this new and important matériel.

FROM a study of the gun and mount in firing and travelling positions several radical departures from previous ordnance design practice are at once apparent. Wheels of the disk type mounting low pressure pneumatic tires of the largest size available commercially are provided. The wheel bearings are of the antifriction type and follow as closely as possible in this respect standard automotive practice. Each axle is spring-mounted in an independent bogie which is in turn clamped to the frame members. Rear wheel brakes designed and produced by a company specializing in this kind of work are used. The center of gravity has been held as near the ground as possible consistent with adequate road clearance. These features unite in giving the vehicle road performance in a high degree.

A battery of four of these mounts was tested exhaustively last fall at Aberdeen Proving Ground in an effort to determine the performance of the chassis under the most severe road conditions. One series of runs was conducted over hard-surfaced roads in hilly country to determine the limiting speed of towing, the performance of the brakes, etc., under the conditions of high speed travel. Here, unfortunately, the speed of the only trucks available proved entirely inadequate to develop the full possibilities of the gun trailer. However, on moderate down grades speeds of 40 miles per hour were attained and no serious difficulty of any description was experienced. In another series of tests the mount performed admirably when towed at high speeds over the roughest unimproved roads in the proving ground area. In the latter case, although the truck was equipped with pneumatic tires, the speed was limited to what the driver could endure, while the brakeman on the trailer experienced no serious discomfort. It is safe to conclude that the mobility of the mount has been proved conclusively from the exhaustive tests conducted and that it is infinitely superior in this respect to its war-time predecessor.

The Comparator and Distant Controller.

The operator at this instrument maneuvers the searchlight to follow the sound locator and detect the target.

4-Meter Stereoscopic Height Finder.

Latest type of instrument employing binocular tracking, telescopes and automatic transmission system to director.

4-meter Stereoscopic Height Finder Manned.

The importance of stability has already been mentioned and should be emphasized here as a feature of primary importance in connection with the new system of *director* firing. The following factors unite in determining the stability characteristics of a carrige: long recoil, low center of gravity and long outriggers. These are the essentials although they might very properly be expressed in another way in the language of an ordnance designer. Perhaps the most striking feature of the new carriage when viewed in the firing position is the extreme length of the outriggers. To forestall any possible criticism in this respect it should be stated at the outset that this length is based on a well known principle of mechanics and is in no way disproportionate. Each outrigger is hinged in two places and pivoted in the main carriage pedestal. In travelling position the intermediate and outer sections are folded over and rest on the main sections which are in turn clamped to the wheel bogies forming the main longitudinal members of the chassis. The handling of the outriggers is greatly facilitated by use of aluminum alloy construction throughout. Two jacks, located on the transvere axis of the chassis, are used for raising and lowering the mount in going in or out of firing position. The recoil mechanism is of the hydropneumatic type giving long recoil with minimum weight. Rustless alloys are used to the maximum extent in its construction with a view to eliminating, in so far as possible, deterioration in storage. The same type of construction is employed in the two pneumatic equilibrators used to balance the muzzle preponderance of the gun. To appreciate the full effect of these features let us turn again to the war-time model 1918 carriage which is so unstable that it must be bolted to permanently emplaced concrete blocks for use in director firing.

Other features of the carriage which might be mentioned in passing are a levelling mechanism by means of which the top carriage can be accurately levelled in two dimensions simultaneously; a folding platform supported by the outriggers and of sufficient area to provide ample working space for the gun crew; and elevating and traversing gears employing antifriction bearings throughout. Experience has demonstrated that hand tools are decidedly perishable articles of battery equipment, and when most needed are generally found missing. With this fact in mind the carriage was designed with a view to the minimum use of hand tools in the recurring maneuvering operations. Thus the carriage can be emplaced, or the reverse, wheels can be changed, etc., with the use of no hand implements other than a stone for tightening or loosening wind nuts, wedges or pins. Incidentally all loose pieces are fastened to the carriage with chains.

A TARGET moving at the speed of an airplane has a wide range of possible maneuver during the time of flight of the projectile. An airplane moving at 100 miles per hour, for example, will travel nearly 1500 feet during the interval corresponding to the time of flight at midrange of the 3-inch antiaircraft gun. It is at once apparent from this fact that any reduction made in the time of flight will be reflected in a corresponding increase in the efficiency of the antiaircraft fire. This has led to the adoption of a gun of high muzzle velocity. The rapid firing of these high velocity guns has given rise to a very serious problem in the rapid erosion of the gun tubes. When we consider that the accuracy life of the gun is limited at most to a very few hours of firing at the conclusion of which it would, under previous practice, have had to be withdrawn from action and returned to an arsenal for retubing, the seriousness of the problem is readily apparent. To take care of this rapid wear and to obviate the necessity for withdrawing the guns from action for an extended period, the loose, or removable liner has been developed, and adopted as standard for this matériel. The liner is, as the name suggests, an inner tube of thin section and moderate weight which can be replaced by battery personnel *in the field*. This operation can be accomplished and the gun restored to its former effectiveness in about fifteen minutes without the use of any special tools or equipment whatever. *The cost of the liner is a fraction of the cost of a new gun.*

Another interesting feature of the gun is the semiauto-

Battery Commander's Observation Instrument.

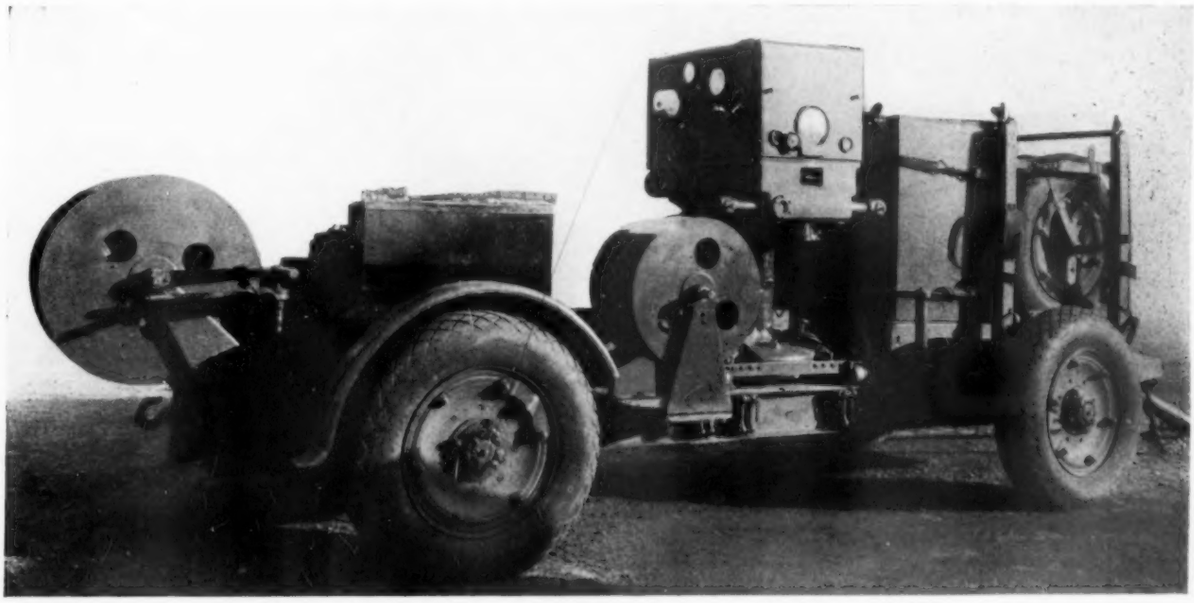
matic breech mechanism which opens the block automatically after the round is fired and ejects the empty shell case. When the new round is inserted in the chamber the block closes, locks in position and is ready for the next shot. This mechanism makes it possible to attain a sustained rate of fire of about 25 shots per minute as compared with 12 or 15 shots per minute using the hand-operated block of the war-time gun.

The mount is equipped with the recently perfected continuous-type fuze setter, generally regarded as one of the greatest improvements in antiaircraft fire-control devices yet devised. It permits the setting of a maximum of 27 fuzes per minute in accordance with data being continuously received from the fire-control director. In operation the instrument is practically foolproof; one operator inserts a projectile into the bell-mouth opening where it is automatically locked in position and cannot be withdrawn before the fuze is properly set; a second operator by means of a handwheel continuously matches two pointers and in so doing maintains the proper fuze range in the fuze setter, while a third turns a crank through two complete revolutions and the fuze is set. It continues to be cut to the proper figure, as that figure changes, as long as it remains in the instrument. This type of fuze setter decreases the dead time—by that I mean the time interval between the computation of data and the firing of the gun on those data—and reduces the percentage of erratic settings to a fraction of one per cent. The continuous type fuze setter is strictly a post-war development.

The following items of Ordnance issue, in addition to the gun and mount, are included in the equipment of an antiaircraft battery: instrument trailer, fire-control director, height finder, antiaircraft battery commander's observation instrument, continuous fuze setter, sound locator and acoustic corrector. The arrangement of the several components in the firing position is shown schematically in an accompanying illustration which appears on page 308.

THE annual antiaircraft exercises held during the past four years have demonstrated quite convincingly the superiority of the indirect, or so-called Case III method, of fire control. The Coast Artillery has recommended the general adoption of this system, which carries with it the elimination of all sighting apparatus from the gun carriage. Before describing this new method it will be of interest, by way of contrast, to mention briefly the principal features of the Case I system which it replaces, and which will continue to be used until the new types of fire-control equipment are available in sufficient quantity for the rearming of our forces.

In the Case I, or war-time system, the gun was equipped with a sighting system embodying a telescope by means of which the gun pointer observed and tracked the target, and a mechanism for setting the gun in advance of the line of collimation of the telescope by the amount of the lateral and vertical deflections corresponding to the travel of the airplane during the time of flight. These data were computed through the agency of several independent instruments, including a two-station altimeter system, an R. A. corrector and a wind and parallax computer. The several instruments performed related and dependent functions, and involved in their operation the reading of scales, reference to graphical charts, and the telephoning of data between instruments. They were altogether slow, inaccurate and highly unsatisfactory. No provision was made for any of the very necessary ballistic corrections, except wind.

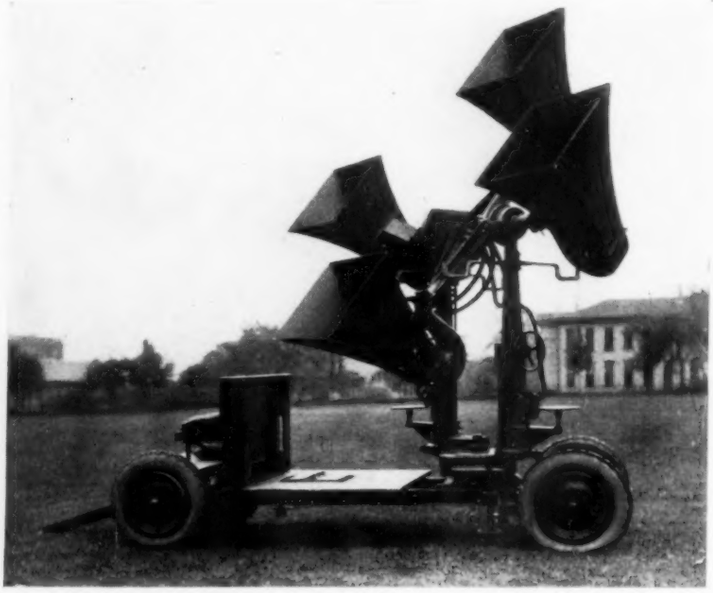


Instrument Trailer with New Ordnance Department Director in Position.

In the Case III system of fire control the gun carriage sighting is replaced by three data receivers which record continuously the future azimuth, elevation and fuze range of the target, received over an automatic electric transmission system from the director. Each receiver is provided with two pointers moving over concentric scales, one of which displays the data from the director and the other the corresponding position of the gun. The gunners have

only to keep the gun continuously laid on the future predicted position of the target by matching pointers. The altitude of the target is read intermittently by a self-contained height finder and transmitted automatically to the director which computes the future position of the target in space. Thus, in our system the functions of several instruments have been consolidated, automatic transmission systems have replaced the many telephone lines, the difficult operation of keeping the sight of a firing gun on the target has given way to the purely mechanical operation of matching pointers, and the accuracy of the several instruments has been very materially increased. To sum up, the principal advantages of the new system are as follows:

1. Reduction of the dead time (time interval between computation of data and laying of gun on those data);
2. No scales to read; hence no errors in setting or reading scales;
3. Data is continuous and not intermittent, therefore, each shot is fired on more accurate data;
4. The rate of fire is increased;
5. Less training of personnel required.



The Sound Locator with Horns Mounted and Ready for Action.

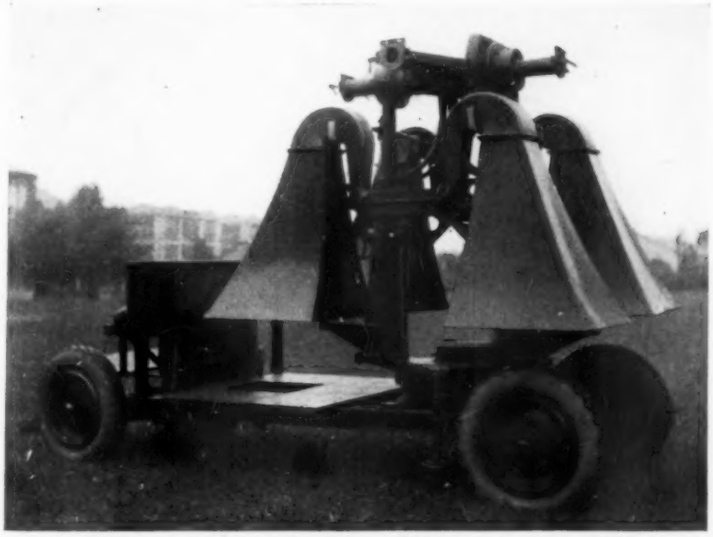
THE antiaircraft director may be regarded as the heart of the antiaircraft fire-control system. It is essentially a supercomputing machine which automatically and continuously observes the target and computes its future position in space. All factors which in any way influence the flight of the projectile, such as wind, atmospheric temperature and pressure, variations in the muzzle velocity from normal, and drift are corrected for automatically within the instrument. Effort has been made in the design of this instrument to eliminate to the greatest possible extent the personnel factor, and to make the various operations as nearly mechanical as possible. Thus, in the latest directors it is unnecessary to read on one scale and set on another, there are no charts to refer to and the essential operations are confined to the simple act of matching pointers moving over concentric dials.

The Ordnance Department has tested the most promising types of directors procurable abroad and in addition has been engaged in the development of a director differing radically from these other instruments. In the latter instrument effort has been made to accomplish a theoretically exact solution of the antiaircraft problem. Many original and desirable features are included, and it is confidently expected that when completed it will be the most valuable instrument of its kind in existence. Two pilots have been constructed and tested with increasingly satisfactory results. It is believed that the development will be completed and the director standardized before the end of this calendar year. Pending the completion of this program we have adopted a very satisfactory instrument of foreign design as standard for manufacture.

Two general classes of height finders have been tested; the stereoscopic and the coincidence type. The stereoscopic instrument operates on the principle of stereoscopic vision, in other words, the organic faculty possessed by the normal individual which permits him to see in depth. This faculty is derived from the spacing of the two eyes and is in a way equivalent to range-finding systems employing two observing stations at the ends of a measured base line, the intersection of whose plotted lines of observation determines the range of the objective. In the stereoscopic instrument, the normal base line between the eyes is in effect increased to the distance between the two objectives thus enabling the operator to locate an actual object at a considerable distance with respect to a known distance within the optical system of the instrument. The coincidence type height finder makes use of the familiar split image principle. Both types measure slant range and angular height and by means of a mechanical and optical mechanism solve the right-angled triangle for altitude. The stereoscopic instrument possesses the unique advantage of being able to permit of sensing the bursts as over or short of the target, and in addition appears to give greater accuracy for the same length of base. For these reasons the Coast Artillery has recommended adoption of the stereoscopic principle. An automatic electrical system is provided for transmitting the altitudes read by the height finder to the director. Let us again turn to the war-time matériel for purposes of comparison. Here we find the two station altimeter system employing two instruments at the end of a base line, each observing the target (let us hope the same target) and telephoning an angular height reading to a central station for computation of the resulting altitude. This system is cumbersome, inaccurate and utterly inadequate to meet the conditions of modern warfare.

IT is very necessary that the battery commander be provided with a satisfactory instrument for observing the effect of the fire on the target. It is equally necessary that he be able to leave the instrument at intervals to supervise the work of the fire-control section and the gun crews. The importance of the time factor will be appreciated when

we consider that the duration of the firing will be measured by seconds, that the battery is firing at a rate of 100 rounds per minute, and that constant adjustment of fire will be required to meet the probable maneuvers of the airplane. The new battery commander's observation instrument has been designed with a view to providing that officer with a means for observing, at any instant, the effect of the fire on the target. It consists, essentially, of two telescopes permanently joined with optical axes parallel; the first, a small finding instrument used by the tracker, and the second, a larger, dual power instrument of wide field for the battery commander. By this arrangement no time is lost in getting on the target, and the dual power feature permits a clear view of the target under changing range and atmospheric conditions. The advantages of this telescope as compared with the old style azimuth instrument are apparent. It is considered an essential part of the modern antiaircraft fire-control system.



Sound Locator Trailer with Horns Dismounted and Locked in Traveling Position.

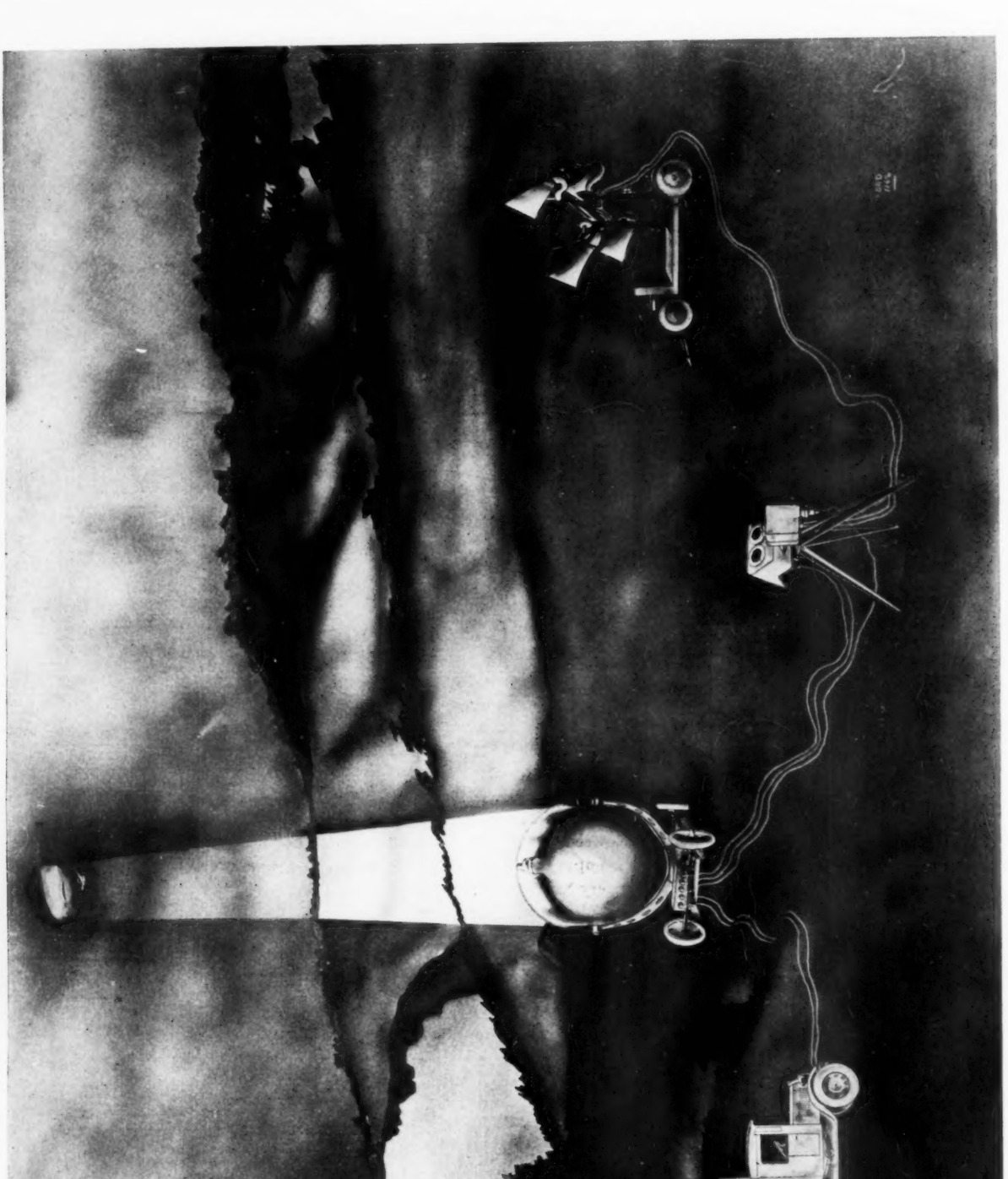
Alternating current power is required for operation of the automatic transmission systems, instrument lighting, etc. It is important that the source of power be unfailing and not dependent on any possible commercial installations. To fill this need a portable generating unit has been provided consisting of two gas-electric generators supplying direct current to a large capacity storage battery which in turn furnishes power for the operation of a small rotary converter delivering alternating current at the desired voltage. This equipment is permanently mounted on a special vehicle called the instrument trailer. This trailer transports all the fire-control equipment of the battery and certain special matériel pertaining to the office of the battery commander. This vehicle has been designed with a view to maximum interchangeability with the chassis of the mobile gun carriage. Thus, the wheels, tires, brakes and many other parts of the running gear are identical in the two vehicles and the problem of spare part supply is correspondingly simplified. Water-tight and dust-proof boxes are provided for each of the instruments comprising the load. These with the pneumatic tires should eliminate the transportation difficulties experienced under the old system where the instrument containers were piled haphazard in the body of a solid-tired truck or transport wagon.

THE detection of airplanes from the ground at night presents new problems and requires additional apparatus. To locate airplanes flying at high speeds in the dark appears at the first thought to be a problem incapable of solution. Indeed experience has demonstrated that it is practically impossible to locate an airplane with a searchlight unaided by direction-finding equipment superior to the human ear. The sound locator has been developed to fill this need. Crude listening devices were used during the war in the antiaircraft defense of Paris and other important localities, but this war-time development did not progress to the point where equipment of any particular value was produced. The present type sound locator may be considered to be strictly a post-war development.

A brief description of the principles underlying the construction of the sound locator will be of interest. Sound is a vibratory disturbance in the atmosphere, or other medium, wherein a pressure wave is set up travelling from the sound source in all directions at the rate of about 1100 ft. per second. This sound wave arrives at a listener's head and unless he is looking in the direction of emission, it will impinge upon the diaphragm of one ear a fraction of a second sooner than upon that of the other ear. The resulting sensations transmitted to the brain are there analysed by point of time with the result that the binaural instinct tells the listener that the sound source is at a certain angle to the right or left. If now the listener turns his head the proper amount, the sound wave strikes both ears simultaneously and is analyzed as coming from the front. This ability of the ears and brain to determine direction acoustically is called the binaural sense; the effect of the sound wave on the ears is called the binaural phase effect.

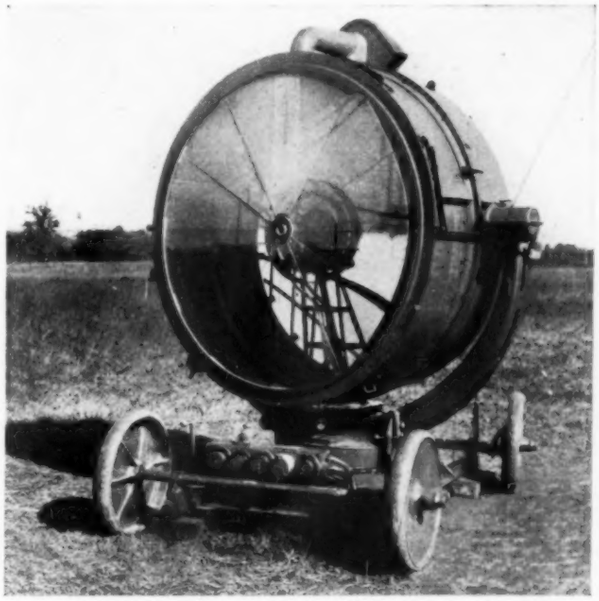
It is evident that if the ears were separated by a greater distance, the difference in time of a sound wave striking one diaphragm over that of the other would be increased and the binaural sense would be sharpened. That is exactly what is accomplished by using a sound locator; two large horns separated by a distance, perhaps twenty times that of the ears, are supported always parallel to each other with their small end terminating at the ears. The sound wave entering both horns travels through each independently until it strikes the ear diaphragms at different instants. The binaural sense immediately tells which way the pair of horns must be swung in order to compensate for the time, or "phase," difference. The listener aims to reduce the phase difference to zero when his ears will receive the sound impulse "in phase" and the horns will be pointed at the source of sound. The direction, either azimuth or elevation or both, can then be read from a scale graduated in degrees. In addition to sharpening the phase effect, the horns, by virtue of their construction act as resonators and amplify the sound.

Since sound maintains its direction after leaving the source, in this case the airplane exhaust or noise of the propellor, and since the airplane moves a considerable dis-



Schematic Drawing of the Searchlight Unit Showing the Arrangement of the Control Instruments and Transmission Lines.

tance during the time required for travel of the sound to the listening horns, it is evident that the apparatus will give us a fictitious direction. To correct this difficulty an acoustic corrector is provided which computes the travel of the airplane during the time of flight of the sound and adds this value to the reading of the sound locator to give us the true present position of the target. The sound locator and acoustic corrector are mounted on a pneumatic-tired trailer designed for towing behind the searchlight truck. The development of searchlights is a function of the Corps of Engineers. This work has been carried forward very ably to give us at the present time an instrument greatly superior to its war-time predecessor. The new mobile 60-inch light will illuminate an airplane target at a range of about 5 miles under normal atmospheric conditions, and at a considerably greater range when conditions are perfect. A pneumatic-tired truck is provided for transporting the searchlight and towing the sound locator trailer. A generator of sufficient capacity to supply the necessary current for the searchlight and transmission lines is mounted as an integral part of the truck chassis.



A Late Model of the 60-inch Antiaircraft Searchlight Developed by the U. S. Corps of Engineers.

The sound locator and searchlight are connected by means of automatic electric transmission systems to a central control station or comparator in such manner as to show at the comparator both the azimuth and elevation laying of the two instruments. These values are displayed by pointers moving over concentric dials. The searchlight may be traversed or elevated by means of a distant controller located at the comparator, and by matching pointers is made to follow the sound locator. The general arrangement of the three instruments in action is shown in the illustration on the opposite page.

WHILE this article has the primary object of discussing the new matériel from the antiaircraft standpoint, it will be of interest to point out that the requirements for a divisional field artillery carriage are in many respects identical, and that a 3-inch antiaircraft mount might well be used for this purpose should the need arise. This is directly in accord with the recommendations of the Caliber Board convened by the War Department soon after the Armistice to lay down a program for post-war artillery development. This Board recommended, in effect, that all new field artillery weapons be designed with a view to possible antiaircraft use. The 3-inch antiaircraft mount is superior to the divisional gun in respect to speed on improved roads, stability and fire power. Its mobility in the field is only slightly inferior to the field carriage. The antiaircraft fire-control equipment could easily be adapted to terrestrial firing. Thus, the present director could be readily modified for this purpose, and would be extremely valuable for fire at moving objects on the ground, such as tanks; the height finder is equally suitable for use as a range finder, while the sound locators are now undergoing test with a view to use in connection with terrestrial sound ranging.

I HAVE stated that our antiaircraft forces, are for the most part equipped with war-time guns and fire control. Included in our forces, and forming a very important part thereof, are a number of active National Guard organizations. The conditions under which the training of these units is carried on are peculiar and worthy of special note in connection with the new types of matériel. The personnel of these organizations are, of course, engaged in civil pursuits during the day, and with the exception of a few days of field duty each year, must receive their military training indoors and at night. It would seem at first thought difficult, if not entirely impracticable, to conduct a satisfactory drill under these conditions, and such is indeed the case with the present equipment. The new matériel, on the other hand, is very well adapted to indoor training. The essential maneuvering operations, in connection with the mount, such as going from traveling to firing position and the reverse, leveling, elevating and traversing in accordance with data displayed on the gun receivers and simulated loading and firing can be accomplished as well indoors as out. The new director is so arranged that it is possible through the agency of special indicator dials, to elevate the telescopes and traverse the director at a predetermined rate corresponding to the travel of an airplane at the desired distance from the battery. The other operators at the director perform purely mechanical functions, such as matching pointers. The height finder and sound locator may be set up and maneuvered indoors, while special indoor training instruments are provided for the stereoscopic observer and the sound locator listeners. In other words, it is perfectly possible to train an organization to a high state of proficiency in an armory, or under any conditions where an airplane target is not available.

I HAVE endeavored to point out in the foregoing paragraphs the importance of stability, mobility, maneuverability and fire power in the mobile antiaircraft gun carriage. I am convinced that the efficiency of the new equipment measured by the old may be expressed conservatively in the ratio of five to one, and that it is at least the equal of that known to be possessed by any foreign power.

Educational Orders for Munitions

The Facts of the Case as Presented to Congress

Part I: Statement of Ernest T. Trigg*

WE begin in this issue publication of statements of leading American manufacturers before the Committee on Military Affairs, U. S. House of Representatives, 70th Congress, 2nd Session, on a Bill (H. R. 450) to provide for Educational Orders to Manufacturers by the War Department. The hearings before the Committee began January 11, 1929.

Educational orders are such a vital part of our Industrial Preparedness plans and the statements in their favor are so convincing that, in the opinion of the Editors, the matters presented at the hearings warrant the fullest consideration. To this end the principal statements before the Committee will be published serially in these pages.

THE EDITORS.

MR. CHAIRMAN, the men who are here to present to you on behalf of the national chamber the need for educational orders in connection with the country's planning for industrial preparedness, are manufacturers who have had a wide experience both with the production of munitions in war times and with the peace-time planning for munitions production in the event of another emergency. They have been invited to come here by the president of the Chamber of Commerce of the United States to give you the benefit of their experience with the practical manufacturing problems involved in getting a commercial plant into war production.

Educational orders, such as are proposed in this bill (H. R. 450), are simply a common-sense means of assisting manufacturers to solve these practical problems in peace time rather than waiting until war time, when each day's delay in the production of the material needed by the country's military forces is costly, when a few months' delay may result in disaster.

Educational orders are not designed to be, nor will they be, a profitable source of new business to American industry. Far from it. Certainly these manufacturers and the Chamber of Commerce of the United States are not in the slightest interested in such orders as a source of new business. We are interested in them from the viewpoint of national defense.

While of little significance commercially, these proposed educational orders are, in the judgment of American business men, of profound and far-reaching significance from the viewpoint of bringing the defense of our country abreast with the industrial era in which we live.

The Chamber of Commerce of the United States is interested in educational orders as an essential element in planning for the Nation's defense, as a result of the action taken by its constituent members at the chamber's annual meeting in May, 1928. At that annual meeting delegates from member organizations adopted the following resolution:

"Modern war is a war of machines and requires these machines in numbers heretofore undreamed of. The capacity of Government arsenals for the manufacture of these machines is small compared with the volume required in time of war. In order that industrial enterprise may in times of peace become familiar with munitions manufacture and be prepared to do its part in war production, it is essential that the National Defense Act should be so amended as to permit the Secretary of War to place with industries orders of an educational character for equipment, munitions, and accessories. In this manner only can commercial concerns obtain familiarity with war requirements and have their place in industrial war plans of the War Department."

As you gentlemen know, the Chamber of Commerce of the United States is a federation of business men's organizations; that is, of chambers of commerce and trade associations. At the present time nearly 1,700 such organizations, representing business interests in hundreds of cities throughout the country and in practically every line of industry in commerce, are in its membership. These organization members are the United States Chamber. It is their action, taken either through the votes of delegates at an annual meeting or through votes on a referendum, and their action alone, which commits the chamber to the principles and policies which it advocates.

We have been asked to present to you on behalf of the national chamber the reasons why the chamber advocates amending the National Defense Act so as to permit the Secretary of War to place with industries orders of an educational character for equipment, munitions, and accessories. I will outline the general relation of educational orders to national defense, as we see it, to be followed by my associates, who will give you the important practical aspects of this relationship drawn from their own experience.

THE World War taught us one outstanding lesson in national defense—the ultimate battlefield where rests the final decision is the factory. Unless we have the facilities and know how to equip without loss of time a modern military force, in which the use of improved mechanical devices for firing and for the transport and protection of men is rapidly becoming more and more important, we are as helpless in face of a well-organized attack as knights

*President of John Lucas and Company, Philadelphia, Pa. Chairman, Committee on National Defense, United States Chamber of Commerce.

on horseback in face of gunfire. To be prepared to raise and train a large army of men willing and eager to defend their country, and not to be prepared to place at their disposal the modern munitions and equipment they must have for an even break in battle is not to be prepared. It is as futile as it would be to build warships without guns, waiting until an emergency arose, not to make the guns, but to learn how to make them.

In the report of the War Industries Board, published after the war, appears this significant statement:

"The prime characteristic of this war was the extent to which it involved the material resources of the participating nations. As attention was turned to immediate preparations it was soon felt that the problem of supplies was going to involve difficulties of the most far-reaching and important character."

We start, then, with the premise that industrial preparedness is a basic factor in any sound policy of national defense. By industrial preparedness we mean the planning ahead of time for the required supplies and munitions, and the training ahead of time of the managers and workers of our factories so that when called upon they can begin producing war material with a maximum rapidity.

Let us look at that proposition for a moment. What are we doing to plan ahead of time for the required supplies and munitions?

Through the National Defense Act Congress has placed upon the Assistant Secretary of War responsibility for this planning work. There has been worked out by the proper authorities in the Army a basic mobilization plan calculated on a war of major effort. With this mobilization of man power in mind, the supply branches of the Army—that is, Quartermaster, Ordnance, Air Corps, Engineers, Signal Corps, Chemical Warfare Service, and Medical Department—have figured out their requirements.

This planning has been carried a step further. Through 14 procurement districts these requirements have been allocated to factories, including Government arsenals, capable of filling them in time of war.

This planning has been carried still further than that. When a commercial plant accepts a schedule of production in case of war it is given specifications and manufacturing information. This is called the factory plan. Such plans involve not only the specifications and often detailed drawings showing the design of the thing to be produced, but required changes in the factory's layout and machinery.

All of this planning is on paper. It is necessary and it is good as far as it goes.

NOW, what are we doing to train ahead of time the managers and workers of our factories so that when called upon they can begin producing war material with a maximum rapidity? This is the weak spot in our industrial preparedness. Let us look at it a moment. When we do we will see the important need for educational orders.

There are certain things which the Army and Navy need in war time for the production of which no previous training on the part of the managers and workers in our factories is required. These are commercial articles, such as shoes, clothing, and so forth.

There are other things which the military force needs which are not produced commercially. Ordnance, of course, for instance, rifles and artillery and their ammunition, is the outstanding example.

We do not have in this country any large privately operated munitions industry, as do some of the countries of Europe. Our Government arsenals have a maximum capacity to produce only from one-half of 1 per cent to 5 per cent of the total requirements in time of war of the various articles of ordnance equipment. For many indispensable articles, therefore, we must rely in war time upon commercial plants which have no experience in peace time with their production.

These factories not only lack experience; they also lack the necessary dies, jigs, and fixtures to produce these noncommercial but indispensable munitions and equipment. The outstanding problem of industrial preparedness is how to provide commercial factories capable of conversion to this specialized kind of war production with the minimum training of personnel essential to keep the art of manufacture alive and with the minimum equipment of tools essential to insure a rapid conversion from ordinary peacetime to war-time production.

In 1922 the Secretary of War suggested a solution to this problem. His plan was "to give annually to a few private plants educational orders for small amounts of selected types of munitions which would serve the retention by such plants of a small nucleus of men capable of producing these types." He contemplated a distribution of these educational orders which would give some experience to as many different plants as conditions permit.

Nothing was done with this suggestion, probably because the accumulation of large quantities of war material during the recent war made the matter seem to be not pressing. In the meantime, more than ten years have now elapsed since the war.

Our surplus war material, particularly ammunition, is rapidly being used up or becoming deteriorated, and most of our surplus equipment is practically obsolete. During this period on account of this surplus our commercial factories have manufactured practically no ordnance equipment or other specialized munitions. Practically all of them have scrapped tools for this purpose which they had during the war. In case of other articles, improvements in them would make new tools necessary anyway. Trained workers who understood the art of this kind of manufacture have been scattered. Truly not a happy situation to contemplate if we take industrial preparedness seriously as a basic element in any sound national policy of defense.

WHAT is needed is some direct and common sense method to create and maintain in our industrial plants a knowledge and experience with the art of manufacturing specialized munitions. Each such plant would necessarily have on hand a complete set of dies, jigs, fixtures, and gages, which in times of emergency could be used as a pattern for the rapid production of additional sets. Each such plant would have a personnel who had learned to iron out manufacturing difficulties in peace time and who in time of emergency could serve as the nucleus for the rapid training of additional workers.

Secretary of War Davis has also suggested educational orders as a practical and economical method of accomplishing this purpose. This suggestion has appealed to the business men of the country, who have become increasingly

familiar with the peace-time problems of industrial preparedness as a result of their coöperation with the Assistant Secretary of War in the procurement planning work his office is carrying on.

What is needed is action on the part of Congress which will give the Secretary of War sufficient discretion to place orders with the requirements of industrial preparedness in mind. This bill (H. R. 450), which your chairman, Mr. Morin, has introduced, does that.

As the matter now stands section 5 (a) of the National Defense Act requires the Secretary of War "to cause to be manufactured or produced at Government arsenals or Government-owned factories all such supplies or articles needed by the War Department as said arsenals or Government-owned factories are capable of manufacturing or producing upon an economical basis."

In practice this means that orders for articles of ordnance must in most cases be given to the arsenals, because the arsenals, on account of their familiarity with such manufacture and their suitable equipment, can do the work cheaper than a commercial plant.

RELIEVING the Secretary of War of this requirement and authorizing him to place educational orders does not mean that arsenals as centers of munitions manufacture will be interfered with. The War Department will keep at all times a force of trained and skilled workmen at these arsenals to keep alive there the art of manufacture and to maintain the arsenals intact ready to receive the full load which has been allocated to them for war production. What the country needs to be prepared industrially is additional units of such manufacture in our commercial plants.

In addition to the limitations placed on the Secretary of War by section 5 (a) of the National Defense Act, there is another law which interferes with the placing of educational orders. This is section 3709, Revised Statutes, which reads:

"All purchases and contracts for supplies or services in any of the departments of the Government, except for personal services, shall be made by advertising a sufficient time previously for proposals respecting the same, when the public exigencies do not require the immediate delivery of the articles or performance of the service * * *."

In connection with this statute the Secretary of War has prescribed:

"Except in rare cases, when the United States elects to exercise the right to reject proposals, awards will be made to the lowest responsible bidder, provided that his bid is reasonable and that it is in the interest of the Government to accept it."

This requirement of competitive bidding for all supplies to be obtained from commercial sources and then awarding the contract to the lowest bidder places a serious limitation on the Secretary of War in carrying out the purpose of educational orders, which is to see to it that the country is industrially prepared.

For example, let us assume that the Ordnance Department advertised for certain munitions to be manufactured by commercial plants in the hope that such an order would operate to better equip such a plant for war production. What would happen? It is entirely likely that the lowest bidder might be some plant to which no war orders had been allocated, a plant which was in no way equipped or suitable for war production and a plant which bid very low merely to carry their overhead during a period of inaction or depression. Attempting to place educational orders under such circumstances is like taking a shot in the dark. What the country's plans for industrial preparedness need is a discretion on the part of the War Department to place orders which will educate those responsible commercial factories on which the country must depend in event of war.

The bill on which these hearing are being held is designed to overcome these legal restrictions to which I have just referred by permitting the placing of educational orders with such responsible commercial plants.

Cavalry and Infantry Organizations to Be Motorized

UPON the recommendation of the Chief of Cavalry, Major General Herbert B. Crosby, the Secretary of War has directed the Commanding General, Third Corps Area, Baltimore, Maryland, Major General Fred W. Sladen, to organize the First Platoon, Troop A, Second Armored Car Squadron (provisional), at Fort Myer, Virginia. This platoon will consist of two officers and thirty-four enlisted men. The platoon is being organized in order that it may conduct the recently authorized field tests to determine the suitability of modified Christie tanks for use by the Cavalry as armored cars. As the Christie armored car also will be tested for possible use with the Experimental Mechanized Force, which will assemble at Fort Leonard Wood, Maryland, this summer, it was desired initially to organize the platoon at a station near that post, such as Fort Myer, Virginia.

This organization will be the second armored car unit of the Army, the First Armored Car Troop having been organized at Fort Myer, Virginia, the early part of last year. During the past summer it participated in the summer training of the Experimental Mechanized Force at Fort Leonard Wood, upon the completion of which it was sent to Fort Bliss, Texas, where, after a march of 2,000 miles, it joined the First Cavalry Division for permanent station.

While several infantry regiments now are partially motorized, the Thirty-fourth Infantry at Fort Eustis, Virginia, will be the first to have all its personnel, ammunition, weapons and supplies carried by motor vehicles. Instructions for the first steps in the motorization of this regiment were issued in May, 1928, but the completion of the project has awaited determination by test as to the required quality and types of certain vehicles. It now has been directed that the motorization be completed by June 30, 1929.

It is contemplated that the transportation of the personnel of the rifle companies will consist of the standard 3-ton trucks of Class B, now in stock. Vehicles suitable for cross-country travel will be furnished for reconnaissance purposes; to carry the personnel, ammunition and weapons of the machine gun and headquarters companies; and for transportation of the supplies and ammunition of field and combat trains. It will be necessary to purchase some of this class of transportation. Suitable for such use are the vehicles developed in recent years, consisting of light cross-country cars; ¾-ton trucks of a four-wheel type with a two-wheel drive and a six-wheel type with a four-wheel drive and 1½-ton trucks with a four-wheel drive.

McFarland's Ordnance and Gunnery

A Review of a New Treatise on Military Armament

By R. H. Somers*

THE advent of a new treatise on Ordnance and Gunnery[1] is a matter of importance, not merely to cadets at the United States Military Academy, for whom a series of such texts have been prepared over a period of many years, but also to the Army at large and to all others who have an interest in the subject. At any given time, the current Ordnance and Gunnery constitutes the nearest approach there is to a general encyclopedia of the ordnance in use by the U. S. Army at that time, and the general engineering principles upon which this material is built. As such, the volume has a much wider field than that for which primarily it has been prepared; and, ultimately when superseded by a later text, it takes its place as a valuable repository of historical information.

Lieut. Col. Earl McFarland.
Professor of Ordnance and Gunnery,
U. S. Military Academy, West Point, N. Y.

The series of which the present text is the youngest member now embraces a total of six, covering the matter of Army ordnance from the period of the Civil War until the present, as follows: Benton, 1861; Metcalfe, 1889; Bruff, 1896; Lissak, 1907; Tschappat, 1917; McFarland, 1929.

It requires no labored argument to show that the period since the publication of Colonel Tschappat's work, embracing as it does the later part of the World War, has been the most active period in the development of ordnance since the beginning of time. The task therefore imposed upon Colonel McFarland has been a double one. On the one hand, he has had to include in this text some mention, however brief, of every important piece of modern ordnance, and every important ordnance activity. On the other, he has had to compress his material into a volume which could be covered by cadets at the Military Academy in the time placed at their disposal for this purpose in a curriculum which itself represents a compromise between the constantly deepening and broadening mental equipment needed by the well rounded Army officer and the limitations imposed by nature upon the mental training which the cadet is capable of absorbing in a four years' course.

This double task has involved the exercise of a continuous series of judgments as to what should be included in the text and what excluded. The treatment throughout necessarily involves a brief outline of general principles followed by cogent practical applications. Descriptions of weapons and service material in general have had to be confined to the most representative illustrations. Limitations of space have precluded an exhaustive treatment of any subject. The book, therefore, is properly to be judged as a whole and from the standpoint of its general balance with respect to the entire field rather than from the adequacy of its treatment of any particular part. Incidentally, it may be pointed out in passing, that from the point of view of the greater number of its potential readers, in addition to the cadets of the Military Academy, it is all the better that such treatment has been necessary. It gives the general student of military affairs the breadth of knowledge which he desires without compelling him to wade through a maze of detail. Likewise, the ordnance specialist along a particular line can readily acquire the knowledge he needs of related lines with an equal freedom from unnecessary labor.

THE general arrangement of Colonel McFarland's text is much the same as that of the text of his immediate predecessor, Colonel Tschappat. The great distance which the science of ordnance has advanced since the publication of the earlier book, however, is evidenced by several new chapter headings which are to be found in the later work. These embrace such subjects as nitrogen and nitrogen fixa-

*Assistant Professor, Military Science and Tactics, Massachusetts Institute of Technology, Cambridge, Mass. Major, Ordnance Department, U. S. A.

1 Ordnance and Gunnery. By Lieut. Col. Earl McFarland, Ordnance Department, U. S. A. Professor of Ordnance and Gunnery, U. S. Military Academy, West Point, N. Y. New York: John Wiley and Sons, Inc., 1929. $6.50.

tion, antiaireraft fire control, motorized matériel, firing tables (how far have we departed from the old "range tables" with their simple tabulations of ranges as a function of elevation!) and the adjustment of fire. Incidentally, it would seem desirable to have found room for at least a brief discussion of the subject of aircraft armament and bombs. Certainly, the place of such material in future warfare is assured.

Chapters I and II of the new text are devoted to propellants and explosives. After defining an explosive and developing the distinction between low and high explosives and a brief sketch of the history of explosives, the questions of ignition and propellants are taken up and the process of the manufacture of smokeless powder is described from the preparation of the raw cotton to the final drying, blending and packing of the finished product. The proof and care of smokeless powder is outlined as well as the methods of making up propelling charges for guns. The first chapter closes with a discussion of the principal high explosives now in use in the military service: TNT, amatol, ammonium picrate, tetryl, etc. The second chapter treats of the theoretical aspects of explosives engineering, developing the classical theory for the computation of the heat given off and the temperature, pressure and other circumstances involved in an explosion in the usual manner.

"THE weapons used by men are but tools, and nations armed by inferior weapons may be hopelessly handicapped. A preponderance of members may make up for this inferiority, if it is not too great. Let us not prepare for war as a game in which the uncertainty of victory might add interest and zest to the conflict. Our duty is to insure that, if war unhappily comes, our country will be able to make such effective use of all its resources that a successful peace may be secured in the shortest possible time."

* * * * *

"The skilled artisan is always thoroughly familiar with and adept in the use of the tools of his trade, and he keeps them in proper condition to perform their functions properly. Correspondingly, it is highly important that line officers understand the problem of Ordnance and thoroughly familiarize themselves with Ordnance matériel. Such a knowledge of Ordnance is essential as will enable them not only to appreciate its powers and possibilities, but also to realize its limitations. Line officers should obviously possess sufficient information, training, and experience along Ordnance lines to enable them to utilize Ordnance matériel intelligently, and to maintain it in such condition that it may function efficiently." Maj. Gen. C. C. Williams, Chief of Ordnance, U. S. Army, in the Foreword to McFarland's Ordnance and Gunnery.

In Chapter III, there is given a discussion of the nitrogen problem as it concerns the explosives engineer. The present sources of nitrogen are tabulated and the various methods of fixation of atmospheric nitrogen are treated from the standpoint of the underlying chemical theory. The chapter closes with a brief consideration of the probable future of the fixation industry.

THE subject of interior ballistics, which is treated in Chapter IV, is developed from the standpoint of Le Duc's equations instead of from the more elaborate and exact method developed by Colonel Tschappat. In view of the audience to which the present work is addressed, this is believed to be the better course. The busy cadet can the more easily and quickly obtain a conception, adequate for his purposes, of the happenings within a gun when it is fired, the mathematical development of which is adequate for many of the problems of the ordnance engineer. An important part of this chapter is that devoted to the effect of variations from standard conditions upon muzzle velocity. This subject is a very important one to the artillerist and, therefore, one which will be of great practical value in the future activity of many cadets.

Regretfully as the present reviewer must acquiesce in the decision to omit Tschappat's method of treatment of the subject of interior ballistics, thus making it not readily available to those who may want to study the subject from the more complete approach—and this approach is essential to the powder engineer and frequently so, or at least very highly desirable, to the gun engineer — if this omission should result eventually in the separate publication of Tschappat's method with its detailed application to the recent powders, it will have proved a blessing in disguise.

Chapter V on proving ground instruments again brings prominently to mind the great activity and advance which the science of ordnance has experienced in the last decade. In addition to very clear descriptions, accompanied by excellent pictures and diagrams of the classical instruments of ordnance proof: the Boulengé chronograph, the Meetagang recorder, the Sebert velocimeter, the Rodman crusher gauge; we find described such new instruments as the Aberdeen and the Solenoid chronographs, the counter-recoil indicator and the Piezo-electric gauge. Colonel McFarland is especially to be congratulated upon this chapter.

Chapter VI, Metals Used in Ordnance Construction, is characterized by a very clear-cut exposition of the metallurgical and metallographic theory underlying modern industrial practice in the manufacture and heat-treatment of steels, both ordinary and alloy. This is written in terms sufficiently nontechnical to be clear to the intelligent layman and the treatment is sufficiently broad to form an excellent introduction to the subject for the more ambitious reader. New matter in this chapter is briefly descriptive of the work of the Watertown Arsenal in the radiographic testing of metals. There is some discussion of nonferrous alloys.

The theory of gun construction is discussed in Chapter VII. The classic theory is developed in very much the same way as in Tschappat's work, although it has been somewhat condensed in order to make room for the other matter. The presentation is very good, but the subject offers little opportunity for originality. An account is given of the newer method of gun making by the cold working or autofrettage process. An excellent feature of this chapter is the description of numerous types of guns

and breech mechanisms and the fine illustrations which illuminate the descriptions. The paragraphs relating to rifling might well have included a reference to typical rifling sections.

Chapter VIII, on recoil and recoil brakes, is introduced by the development of the theory of recoil in the usual manner. This is followed by descriptions of the most generally used types of recoil mechanisms, hydro-spring, hydro-pneumatic, etc. New material in this chapter relates to the applications of the general theory to specific carriages and especially to pneumatic recuperation. As elsewhere, excellent outline drawings accompany the text.

Artillery, is the subject of Chapter IX. This chapter is practically entirely new. Naturally, it would have been impossible to introduce descriptions of all the numerous types of artillery — mobile, antiaircraft, railway and seacoast—which are now accepted Army standards or which, although no longer standards for new production, still remain in service as effective weapons of national defense. But selection has been made of a sufficient number of representative weapons to illustrate all of the newer types and the more important of the older ones. These include the 3-inch antiaircraft mount, Model 1917, the 16-inch barbette mount, the 14-inch railway mount, as well as several others. Again attention must be called to the wealth of illustration.

THE science of practical gunnery and fire control has undergone, perhaps, during and since the World War, a more revolutionary change than any other with which the ordnance engineer has to deal. Certainly the introduction of third dimension firing occasioned by the advent of aircraft and the necessities of warfare of position have been tremendously stimulating agencies. Chapters X, XI, and XII on aiming devices, fire-control instruments, and antiaircraft aiming and fire-control devices, respectively, set forth the theories at present current with respect to fire control and contain descriptions of the principal instruments now being used. The basic theory is set forth with clarity and conciseness and, except in the chapter on antiaircraft aiming and control devices, the principal instruments are illustrated and the methods of their use described.

Chapters XIII and XIV contain as much of the theory of exterior ballistics and its application to firing tables as is necessary to permit the intelligent use of these tables in practical gunnery. As in the case of interior ballistics, it appears to have been decided that to attempt to go too far into a highly complex subject would be unwise. For the audience to which the book is addressed, clear-cut basic conceptions, rather than a knowledge of the mathematical steps in translating these conceptions into form for practical use, constitute the object to be sought. The artillerist must necessarily assume that his firing tables have been computed with the same integrity that he readily concedes to his tables of logarithms. In this point of view the reviewer heartily concurs.

Chapter XV on the probability and adjustment of fire, which presents an important subject in an excellent manner, has been abridged, almost verbatim, from Training Regulations 435-280.

Colonel McFarland introduces his chapter on projectiles (XVI) with a short introductory sketch of the historical development of elongated projectiles, followed by a description of the important types of modern projectiles, with some discussion of the respective uses of these types and the basic considerations governing the design, and a short description of manufacturing methods.

Chapter XVII, primers and fuzes, contains descriptions of the principal service primers and fuzes, including such recent developments as the super-sensitive fuze and the super-quick short-delay fuze. All the important service fuzes are described and amply illustrated.

THE subjects of small arms and small-arms ammunition and machine guns and automatic rifles are treated in Chapters XVIII and XIX with the clearness and thoroughness naturally to be expected in view of Colonel McFarland's intimate association with matériel of this character over a long period of years in the Office of the Chief of Ordnance, at Springfield Armory and in the field. The present service types are described in considerable detail, their characteristics and limitations are pointed out and considerable data are given on their use and functioning.

In his treatment of motorized matériel in Chapter XX, Colonel McFarland, advisedly, confines himself to descriptions of leading standard and experimental types of tanks, tractors, and self-propelled mounts. He avoids discussion of the controversial subject of the possible extent to which mechanization of armies may go in future warfare. The closing chapter of the text, XXI, contains a description of the present standard hand and rifle grenades of the U. S. Army. A chronological outline of ordnance development follows the subject matter of the text. The reviewer has never previously seen such an outline and finds it of great interest. Beginning with 1300 B. C., the development of ordnance from the lance, sword, sling, and bow is carefully outlined, period by period, up to the rapid development of all arms, ammunition, and equipment in the years subsequent to the World War.

Although the present text contains fewer pages than its predecessor, 625 as against 705 for Colonel Tschappat's book, the printed pages are larger, and the type finer so that the actual textual material contained is probably considerably greater. References at the end of each chapter, with few exceptions, list the more important articles and works covering the subject of the chapter.

COLONEL MCFARLAND has made a noteworthy contribution to the literature of ordnance. He has maintained the same high quality that has characterized the texts of his predecessors and he has produced a volume which will be invaluable to the ordnance engineer, the artillerist and the general student of military affairs. The text assembles within one cover a large bulk of fundamental information in a form which will be at once intelligible to the layman and valuable to the more expert reader. That the author's motive in preparing this text has been solely that of a conscientious desire to fill a demonstrated need is evidenced by the fact, known to the reviewer, that he has refused to accept royalty or any other form of remuneration from sales of his work.

A review of this sort would not be complete without some attempt to give credit before their colleagues in the Ordnance Department and elsewhere to those who have rendered material assistance to the author in the preparation of his text. These, as stated by the author in the preface of the book, are Colonel Tschappat, Capts. H. A. Nisley and W. I. Wilson and First Lieuts. W. A. Broberg and G. M. Taylor, all of the Ordnance Department.

The Alum Chine Disaster

On March 7, 1913, the steamer Alum Chine was in Baltimore harbor being loaded with 12,000 cases of saltpeter dynamite. One phase of the testimony was that a stevedore used a cotton-hook on a case of dynamite with such force that the case exploded, causing a fire on the ship. Other testimony placed the origin of the fire elsewhere, cause unknown. About 20 minutes later the dynamite cargo exploded, killing 27 men and injuring 39 others, with property loss of $850,000.00. The casualties and damage were partly on other vessels in nearby waters and adjacent property.

The Bureau of Explosives

Its Progress Toward Safety in Handling and Transportation

By Beverly W. Dunn*

IN April, 1905, Mr. James McCrea, then Vice-President of the Pennsylvania Railroad, advocated before the American Railway Association the appointment of a committee to prepare regulations to promote the safe transportation of explosives. For more than 15 years the railroads had struggled by individual efforts to decrease the chances in favor of fires and explosions on railroad property. These efforts had not prevented many serious disasters. The necessity for some concerted action by all roads was apparent.

The efforts of Mr. McCrea were followed by the appointment of a committee on explosives and other dangerous articles to prepare and present to the American Railway Association at its meeting in October, 1905, a set of regulations for the transportation of explosives, in order that after approval by the Association these regulations might be recommended to its members for individual adoption and enforcement. While the personnel of this committee was still under consideration, one of the most disastrous explosions that had ever occurred in the United States happened at Harrisburg, Pa., on May 11, 1905. Twenty lives were sacrificed and the financial loss exceeded $600,000. During the summer of 1905, the committee worked diligently on the preparation of the regulations, employing additional civilian experts on explosives and consulting representatives of the Ordnance Department of the Army and the Navy Bureau of Ordnance.

The regulations prepared by the committee were approved by the Association in October, 1905, and adopted promptly thereafter by practically all of its members. This uniform adoption and publication of the regulations, essential as it was, did not produce any marked change in the handling of explosives.

In October, 1906, a year after their adoption and publication, the Association decided that some central agent of all the roads was necessary for uniform enforcement of these regulations, and it approved a constitution and by-laws for the "Bureau for the Safe Transportation of Explosives and Other Dangerous Articles." Membership in this bureau was optional and it was not until seven months later that the practical work was started by opening the office of the chief inspector in New York City. The writer was granted leave of absence from his Army duties and assigned by the President to assist the American Railway Association in organizing the work of the Bureau of Explosives. At this time (June, 1907) the membership comprised 78 railroad companies, operating 136,026 miles.

In 1913 the constitution of the bureau was changed so as to permit the inclusion in its membership of manufacturers and shippers of explosives and other dangerous articles, and manufacturers of shipping containers therefor. At the present time (January, 1929) the bureau mem-

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bership comprises 498 railroad companies, operating 304,656 miles, 120 associate members, 11 steamship companies, and 4 express companies.

A STATUTE, passed by Congress in 1866 to regulate the packing of explosives for transportation, was impractical and obstructive to safe transportation, and one of the first steps necessary was the repeal of this obsolete law. Through the efforts of the principal manufacturers of explosives and representatives of the carriers, this was accomplished by the Federal Law of May 30, 1908, now codified by the Act of March 4, 1909, as Sections 232 to 236, and amended by the Act of March 4, 1921. Section 233 requires the Interstate Commerce Commission to formulate and the carriers by land or water to enforce reasonable regulations to promote safety. In Section 233 of the Act of March 4, 1921, the following appears:

"* * * * In the execution of the provisions of this Act the Interstate Commerce Commission may utilize the services of the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles * * *."

The Commission has recognized the work of the Bureau of Explosives and in its regulations has delegated to the bureau certain duties in connection with inspection and enforcement of the rules.

The constitution and by-laws provided, by a general scheme, for dividing the work of the bureau among (first) a directing headquarters of the bureau, the office of the chief inspector; (second) a chemical laboratory with the necessary personnel and testing and analytical apparatus; (third) a force of traveling inspectors. The duties of the traveling inspectors are as follows:

Inspection of factories where explosives and dangerous articles other than explosives are manufactured and prepared for shipment.

Inspection of factories where containers for the shipment of explosives and other dangerous articles, as prescribed by the Commission's specifications, are manufactured. Conducting tests of such shipping containers for the purpose of arriving at definite conclusions as to requirements necessary for safety in their handling and transportation.

Taking and forwarding of samples of explosives and other dangerous articles to the chemical laboratory of the bureau for the purpose of ascertaining whether or not they are safe to transport, and to verify or advise packing requirements.

Inspection of storage magazines in which explosives are stored and from which shipments are made by rail.

Condemnation of explosives which are unsafe for shipment by rail, and forwarding of samples to the chemical laboratory for examination to ascertain whether or not repacking may be done with safety, or whether destruction is necessary or whether modifications are required.

The Result of Carelessness

This fire occurred at Memphis, Tenn., January 24, 1921. An employe of a local oil company, ignoring the dome-caution placard and the warnings and instructions of the I. C. C. regulations, removed the dome-cover of a tank car of casinghead gasoline without first relieving the internal pressure in the car. As soon as it was sufficiently loosened, the cover blew off and a great quantity of liquid spurted out. Drifting vapors from this were ignited by a fire—probably a cookstove—in one of the dwellings on an adjacent block. An explosion resulted, of such violence that all the wooden buildings in that block were demolished or damaged. A flash-back to the vapors around the oil-plant occurred, causing a second explosion and fire. 13 deaths and 18 injuries, as well as at least $150,000 property loss resulted.

Supervision of the repacking or other disposition of condemned or leaking explosives or other dangerous articles discovered in transit or on carrier's property.

Supervision of repacking or other disposition of condemned explosives in storage shipping magazines.

Inspection of steamship, express and railway stations, cars, yards, terminals, wharves and piers, and instruction of employes at these points in the requirements of the Interstate Commerce Commission regulations.

Reports of inspections are submitted to designated operating officials of all lines included in inspectors' districts to inform them of the conditions observed, and copies are furnished the chief inspector. Inspectors also make special investigations and inspections at the request of transportation members.

WHEN the regulations were first promulgated by the individual roads, the manufacturers of explosives did not comply willingly and the principal cause of their opposition was a fear that their competitors on other lines might avoid the expense of a more careful preparation of their shipments and thus secure a trade advantage. Shortly after the office of the chief inspector was opened in 1907 a conference was invited which was attended by a majority of the manufacturers of explosives. The situation was thoroughly and frankly discussed and the coöperation of the manufacturers secured. A similar situation was later met and coöperation secured with the manufacturers of other dangerous articles and shipping containers therefor.

The Aftermath of Neglected Shipping Regulations

On June 14, 1921, at Wallerville, Miss., there occurred a head-on collision between two freight trains. In one train, in violation of the I. C. C. regulations, a box car containing 600 cases of gelatin dynamite had been placed next to the engine. No explosion resulted from the collision itself, but about ten minutes afterward, fire, probably from the firebox of the engine, reached the scattered dynamite, which exploded, blowing a crater fifty feet square and twenty deep in the ground and destroying both locomotives and nine cars, with a property loss of $141,625.00. Had the dynamite car been, as required by I. C. C. regulations, at least 15 cars from the engine, there would probably have been no explosion.

Investigation of all fires and explosions involving explosives or other dangerous articles in transit, or in storage on carrier's property.

Instruction and education of shippers of explosives and other dangerous articles to prevent violations of the Interstate Commerce Commission regulations.

Examination of designated railway employes for the purpose of ascertaining whether or not they are qualified to superintend and handle explosives and other dangerous articles.

Inspection and investigation of conditions and submission of recommendations for the safe location of factories where explosives and other dangerous articles are made, including magazines for the storage of explosives, tanks for storage of inflammable oils and loading and unloading racks for inflammable oils, with the view of securing the safety of the traveling public.

With the growth of the work of the bureau the test and specification department was developed. The duties of this department are as follows:

Development of specifications for shipping containers of explosives and other dangerous articles to meet safety requirements of transportation conditions.

Examination and tests of packages and approval of their use when found acceptable and safe.

The work of the bureau is supervised by an executive committee of railway officials, to whom the chief inspector reports periodically.

HOWEVER unwelcome the duty, a common carrier must transport the explosives and other dangerous articles demanded by commerce and construction work, and the risks must be minimized by the adoption of all practicable precautions.

Regulations governing this transportation are now Federal law, and the law also prescribes that the carrier and shipper must make the regulations effective by thoroughly instructing their employes in relation thereto.

Nitric Acid a Serious Fire Hazard

The above picture does not represent the accident herewith described, as it was impossible to obtain one; but the picture will serve to indicate that nitric acid, especially when not properly packed, presents a serious fire hazard.

On October 17, 1915, at Summit, California, a freight train stopped on a siding to permit passenger trains to pass. A few minutes later, a box car in the train was found to be afire. The train was standing in a snowshed at the time, and the car could not be isolated till the fire had gained great headway. The car was practically destroyed, together with nearly 2,000 feet of the snowshed, 14 additional cars, and much other railroad property, the loss being $165,000.

Subsequent investigation showed that the car in which the fire occurred had contained bottles of nitric acid packed with combustible cushioning material, into which some of the acid undoubtedly leaked.

The mere issuance of an order publishing the regulations will not comply with the law. The united experience of all railways in the United States shows that the regulations do not enforce themselves; that instructors are needed to educate and inspectors to enforce the rules by the discovery of delinquencies. These regulations mean restrictions on railway employees and shippers, and these restrictions call for the expenditure by both of time and labor. A shipper will object strenuously to expensive restrictions if his competitor is allowed to escape them. These competitive influences will also affect the traffic departments of railways. In the interest of safety a road is almost as much interested in the enforcement of the regulations by its connections as in the enforcement of the regulations over its own line, since danger may come through shipments received at junction points. It is evident, therefore, that uniformity of application of the regulations over all competing and connecting lines is essential to their effective enforcement over an individual line.

The Bureau of Explosives is entirely free from all competitive influence and works equally in the interest of all members. It has been able to secure the active coöperation of large shippers and manufacturers, because they appreciate the advantage to them of a railway organization possessing technical knowledge of their industries. To comment intelligently on the points that arise constantly in correspondence requires not only this technical knowledge in some official like the chief inspector, who is available to all members of the bureau, but the facilities also of a chemical laboratory where examinations and analyses of samples can be made.

The advantages of associate membership in the Bureau are:

1. To assist in a worthy public service: coöperating with carriers.

2. Use at actual cost of the facilities of the chemical laboratory and services of expert chemists.

3. Receipt of copies of all circulars, regulations, bulletins, and annual reports giving the details of fires and explosions reported, and the results of investigations relating to the work.

4. Opportunity to assist in the drafting of proposed amendments to the rules and to shipping container specifications.

The principal advantage to the bureau of the associate membership of an individual, firm or company is: The members take more interest in seeing that their own employees are properly instructed and that they comply with the regulations.

AT the close of the World War in 1918 it did not seem possible that the principal events of that year could ever be approximated in our national experience. For some time to come the one event, the winning of the war, will crowd all others into the background of our mental vision. When we are able to focus our minds on other events, the services rendered by our railroads will stand out in bold relief and in the foreground of this picture will appear the successful transportation of enormous quantities of such dangerous articles as explosives, poisonous liquids and gases, gasoline and acids.

Our military program, adopted early in 1918, called for a production in one year of about two billion pounds of explosives for military use, and for the production of poisonous liquids and gases at a maximum rate of about 200 tons per day. The actual production attained under this program cannot be stated, but it is known that for most of the year preceding the signing of the Armistice, the monthly production of military explosives exceeded eighty million pounds, or more than two thousand carloads of 40,000 pounds each per day. These explosives moved to the loading plants where each carload of explosives produced not less than five carloads of explosive projectiles. Allowing ten days for the average movement to destination, and considering less-than-carload shipments as well as carload shipments, a conservative estimate shows that the railroads of the United States during the busy

months of 1918, had at all times not less than fifty thousand cars in transit on Government business and bearing the explosive placard. This was in addition to the average of five thousand cars in transit to meet the normal commercial demand, and our estimate does not include the cars bearing military explosives in Canada.

In meeting this abnormal demand only 11 accidents of all kinds occurred in the transportation of explosives during 1918, only four persons were injured, only one life was lost; and the total property loss was only $33,238. Of these results the only one chargeable to war material was the loss of one life, which occurred in Canada.

This excellent record was due, primarily, to the general use of standard packages and of standard methods in loading, blocking and bracing the packages in cars. Such standardization was secured more readily for explosives than for many of the other classes of dangerous articles on account of the relatively small number of shippers of explosives, and their very general appreciation of the necessity for strict compliance with the regulations. The record should be an object lesson to shippers of other dangerous articles and to operating officials of railroads.

The signing of the Armistice in November, 1918, caused a sudden stoppage of overseas transportation of explosives, and this was followed by a dangerous accumulation of loaded cars in railroad yards at embarkation points. At Pigeons Point in the suburbs of Wilmington, Delaware, this accumulation reached at one time a total of 228 cars containing about 14,000,000 pounds of explosives. When we recall that eight carloads caused the damage at Black Tom Island in July, 1916, it is easy to understand the demands for relief that came from the Mayor of Wilmington and Congressional representatives of Delaware at Washington. This experience emphasized again the usefulness to the railroads, and to the country at large, of a central organization such as the Bureau of Explosives, equipped to handle an emergency of this nature. The Director General ordered the removal of the explosives from the Wilmington yard and authorized the dumping of them at sea under the supervision of the bureau. Our inspectors were in close contact with the work, which required weeks of time and presented many practical difficulties even after completing the transfer from the cars to lighters at South Amboy, N. J. One difficulty came from the failure of the lighter crew one stormy night to follow instructions that required the opening of all packages before throwing them overboard. Although dumped at sea twenty-two miles southeast of Sandy Hook, these unopened packages floated ashore several days later along the southern coast of Long Island. Fortunately, they were located and disposed of without accident.

TABLE No. 1, headed "Explosives," shows the losses and casualties in transportation of explosives that have occurred each year since the work of the Bureau of Explosives began. Table No. 2 shows "Explosives," as one class, and "All Other Dangerous Articles" as another, with losses for the years 1924 to 1928, inclusive. The percentage of each year's property loss for each of the two classes is also shown. As gasoline forms such a preponderant part of the property loss, figures for this commodity, with percentages of each year's loss, are given separately. Similarly, since a very large proportion of losses are the result of wreck or derailment, a factor beyond the responsibility of the bureau, percentages are shown for each of the five years covering this source of trouble.

TABLE No. 1—Explosives

Accidents Resulting in Explosions or Fires, in Transportation of Explosives by Rail or on Carriers' Property Awaiting Removal by Consignee—1907 to 1928, Inclusive

YEAR	Number of Accidents	Number of Persons Killed	Number of Persons Injured	Total Known Property Loss
1928	12	0	0	$ 77
1927	4	0	0	45
1926	20	0	9	46,011
1925	28	0	0	13,410
1924	16	1	3	12,178
1923	16	6	32	79,890
1922	8	0	1	75
1921	19	3	22	232,439
1920	11	1	12	32,660
1919	10	2	2	53,220
1918	11	1	4	33,238
1917	5	0	1	9,590
1916	17	5	107	10,762,766
1915	11	0	6	127
1914	11	0	7	14,106
1913	11	0	4	22,048
1912	9	0	6	10,200
1911	10	1	5	34,761
1910	16	2	1	43,636
1909	12	6	7	2,673
1908	22	26	53	114,629
1907	79	52	80	496,820

In interpreting these figures, certain points should be borne in mind: (1) The actual loss in any case depends largely upon the quantity of dangerous material which happens to be present. The mishandling of a single package might cause a fire; if this package were the only inflammable or explosive material present, the loss would be small, whereas if a large amount of dangerous material were at hand, the resulting loss from the same small cause might be large. (2) Whatever basis of comparison is used, the losses chargeable to explosives have been held down in a most gratifying manner. (3) Losses in commodities other than gasoline have been forced fairly steadily downward. In the case of gasoline, the amount of it shipped far exceeds that of all other dangerous commodities and increases annually much faster than any other hazardous commodity.

Table No. 2.—Summary of Reported Explosions, Accidents and Fires in Transportation of Explosives and Other Dangerous Articles, 1924 to 1928

Year	Explosions	Killed	Injured	Loss	Percentage	Dangerous Articles	Killed	Injured	Loss	Percentage	Gasoline (for Comparison Only)	Killed	Injured	Loss	Percentage	Percentage Due to Wreck or Derailment.
1924	16	1	3	$12,178	0.61	1446	11	119	$ 746,088	98.39	301	9	16	$641,671	84.62	91.64
1925	28	0	0	13,410	0.81	1725	13	51	1,626,052	99.19	328	10	15	636,778	38.84	42.39
1926	20	0	9	46,011	5.19	1486	1	22	1,052,189	95.81	284	3	5	649,033	59.09	83.29
1927	4	0	0	45	0.007	1439	5	34	632,934	99.993	347	5	13	372,912	58.99	92.93
1928	12	0	0	77	0.009	1205	14	107	816,888	99.991	360	9	5	709,821	86.88	92.61

Bombs and Bomb Fuzes

A Discussion of Trends in Modern Design

By S. R. Stribling*

AN inventor recently submitted to the War Department a design of a bomb which was called the "Bee Bomb." This bomb consisted of a container full of live bees. The inventor claimed his device to have great tactical value because the bees would be quite angry when released on impact of the bomb and would violently sting the enemy thereby causing great confusion in the enemy ranks. Another interesting design submitted was the "Skunk Bomb." This really should have been classed as a gas bomb.

The design of weapons such as the above would probably have been hailed as great achievements in prehistoric days. But modern bomb design must follow along scientific rather than visionary lines. It is not the purpose of this paper to enter into a technical discussion of design problems, but rather to furnish the reader with information relative to the general requirements to be met by modern bombs and bomb fuzes.

In the design of bomb bodies and fin assemblies there are certain basic requirements which must be met even though this means the sacrificing of other desirable characteristics. The Army Air Corps is charged with the design of bomb racks which carry the bombs designed by the Ordnance Department. The overall dimensions of the complete bomb and spacing of the suspension lugs must therefore be such that the bomb can be carried on standard bomb racks without interference with structural members of the airplane. The bomb compartment of modern bombardment airplanes is designed to carry bombs varying in weight from 100-lbs. to 1100-lbs. This compartment is inside the fuselage of the airplane, and necessarily must be free from structural members. The airplane designer cannot allow this open compartment to be too large as structural weakness of the airplane would result, due to this internally unbraced section. The bomb designer must therefore design the bomb so that it can be carried in this compartment and be released without interfering with members of the airplane. This requirement limits only the size of the heaviest bomb as the smaller ones can be easily carried in the compartment. Vertical suspension of bombs to decrease the necessary size of the bomb compartment has been considered, and was used to a limited extent during the World War, but was abandoned due to the resulting bad flight characteristics of the bomb. Internal suspension of bombs is decidedly more desirable than external suspension due to the decrease in head resistance with consequent increase in lifting capacity and speed of the airplane when the bombs are not in the air flow.

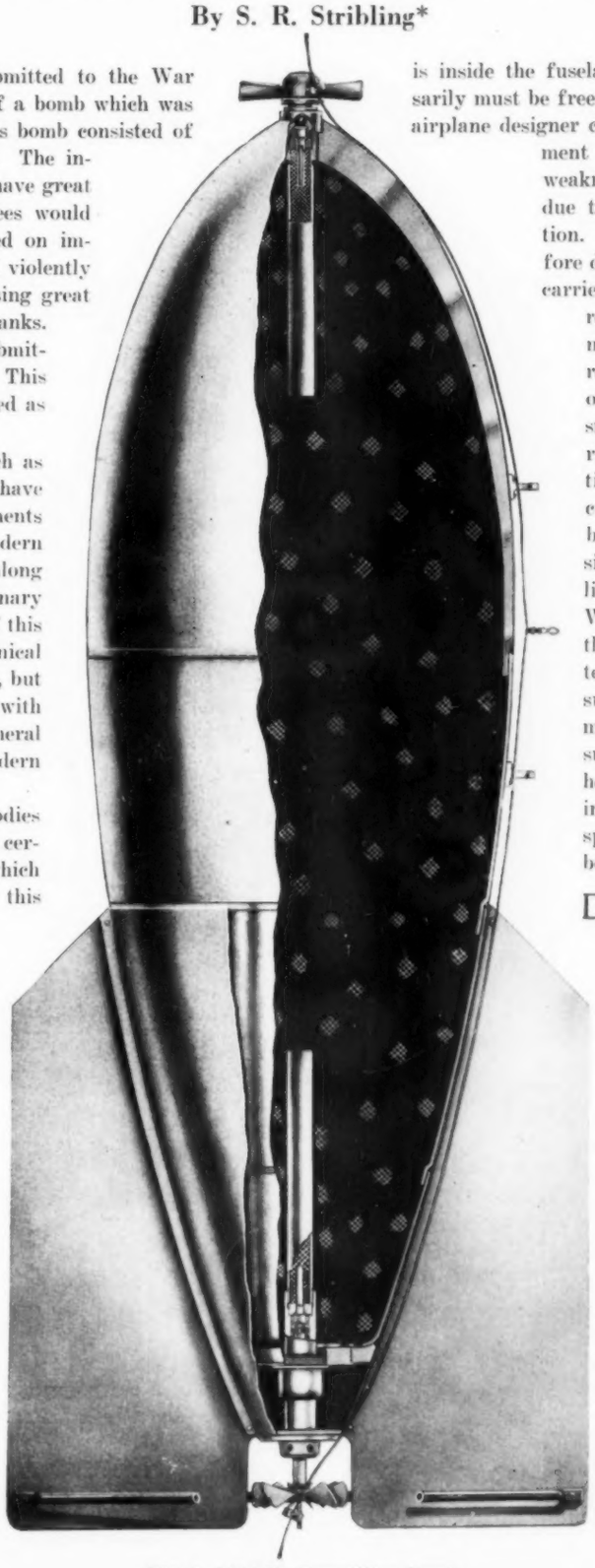

Fig. 1. 1,100-lb. Demolition Bomb.

DEMOLITION bombs will normally be equipped with delay action fuzes which will cause the bomb to function a short time after impact. This is desirable due to the greater destructive effect resulting if the bomb is allowed to penetrate the target before functioning. Therefore the bomb body or case should be of sufficient strength to withstand the forces of impact; otherwise the explosive may be scattered provided the case breaks up before the fuze functions. Since it is desirable that a demolition bomb contain the maximum percentage of explosive, the wall thickness of the body is made the minimum commensurate with strength. Basic data for these com-

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putations are obtained by dropping sand-filled bomb cases on a specially constructed concrete surface at Aberdeen Proving Ground.

The stream line metal bomb bodies or cases of war-time demolition bombs of smaller sizes, 25-lbs., 50-lbs., and 100-lbs., consisted of pressed steel sections joined with circumferential and longitudinal welds, the nose sections being thicker than the rear. The larger war-time bomb bodies, 300-lb., 600-lb., and 1100-lb., of stream-line type had cast steel noses with rear portions of pressed steel made up of sections joined by circumferential and longitudinal welds. These war-time designs proved generally unsatisfactory due to the weakness of the longitudinally welded joints.

Immediately after the Armistice new designs of demolition bombs from 100-lb. to 1100-lb. of stream-line type were undertaken. The 100-lb. bomb was built up of deep drawn nose and rear body sections joined together with circumferential welds. No longitudinal welds were used. The 300-lb., 600-lb. and 1100-lb. sizes were designed with cast steel noses and deep drawn rear sections joined with circumferential welds. These post-war designs were found to meet satisfactorily the strength requirements laid down as a result of experience gained during the war.

IN 1921 the requirement was set up for a 2000-lb. bomb to be used in bombing tests of former German war vessels. In laying down the design of this bomb it was decided to adopt a cylindrical type of body based in general on the British 1600-lb. bomb which had a riveted drum body. The body of the first 2000-lb. bomb was made up of a seamless steel body forging, using the pierced billet method, with cast steel nose riveted and welded, and a rear cap welded thereto. Later designs of this same size bomb eliminated the nose casting and carried the nose integral with the cylindrical part of the body forging, thus giving greater strength.

The manufacture and test of the 2000-lb. bombs have indicated the cylindrical type of construction to have distinct advantages over the war-time stream-line type of body construction. Projects have therefore been initiated, calling for the development of 100-lb., 300-lb., 600-lb., and 1100-lb. cylindrical body type demolition bombs. In designing the 300-lb. size it was found that a satisfactory body forging could be obtained by the commercial cupped-plate method of drawing seamless steel tubing. The cupped end of the forging was machined down to the desired nose thickness. No machining on the interior of the forging was found necessary, a satisfactory inner contour of nose end being formed by the mandrel used in the drawing. This process eliminated forming the nose end by the difficult swaging process used on the latest design of 2000-lb. bomb. Indications are that satisfactory forgings for the 100-lb., 600-lb., and 1100-lb. sizes can be obtained by this method of manufacture.

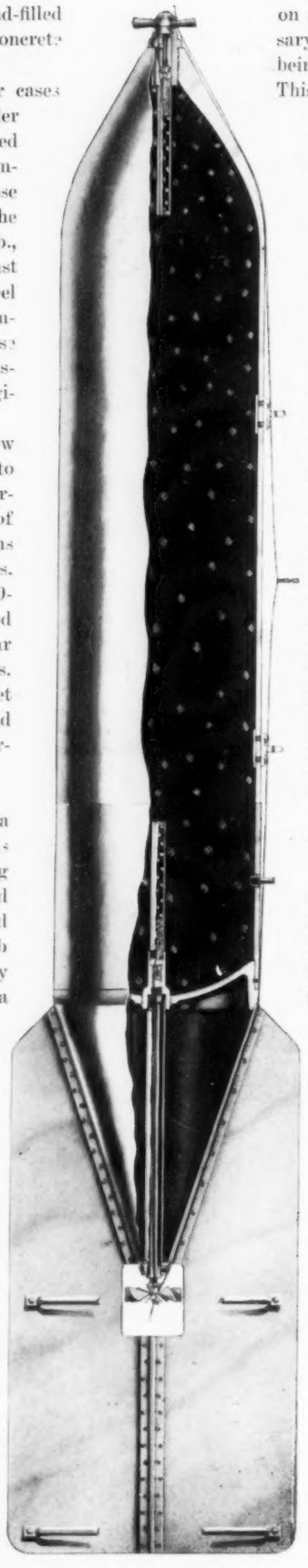


Fig. 2. 2,000-lb. Demolition Bomb.

Considerable study has been given to the practicability of eliminating the rear cap casting in bomb bodies of the cylindrical type. A design of the 600-lb. size has recently been completed by which the rear end of the cylindrical part of the body is spun in or swaged to form the rear cap, thus eliminating the need for a rear cap casting of large diameter. If found satisfactory from a manufacturing standpoint, and commercial concerns have expressed the belief that it will be so, this type of body construction will represent a distinct step forward due to the fact that the body will be strictly of one piece; that is, with the nose and rear cap integral with the cylindrical part. Thus all joints of large diameter which have proved so troublesome in the past from the standpoint of machining, strength and leakage, will be eliminated. Such a body is especially desirable for chemical bombs because of the effect of the chemicals on welded joints.

THE fin assembly for a bomb must be designed carefully so as to obtain proper stability, since bombing accuracy depends largely on the ballistic qualities of the bomb. Basic data for these computations are obtained from wind tunnel tests of models at the Bureau of Standards and from ballistic data, of bombs of similar design, determined at Aberdeen Proving Ground. These tests not only furnish data for future designs of bomb bodies and fin assemblies, but indicate how the flight characteristics of present bombs can be improved. For instance, it was discovered by recent tests at the Bureau of Standards that by actually decreasing the fin area on the 100-lb. war-time bomb by cutting away part of the forward part of the fins, which resulted in moving the center of pressure farther back, the ballistic qualities were greatly increased, resulting in more stable flight of the bomb. The fin assemblies of war-time design were generally unsatisfactory. The method of attachment to the bomb body was by means of four screws, which necessitated the removal of the fin assembly in order to insert the tail fuze. The fins were not properly braced and the material was too light to prevent damage in

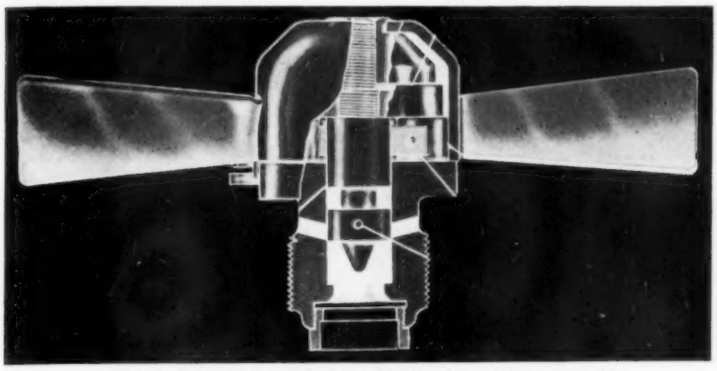


Fig. 3. Nose Fuze, Mk. VII MI, for Demolition Bombs.

handling. Present designs of fin assemblies overcome these objections, and the attachment to the bomb is independent of the fuze, which allows the use of the same size and type tail fuze in all sizes of bombs. Fin assemblies for the latest type bombs are manufactured from sheet aluminum, thus materially decreasing the weight. The fins are rigidly braced and of sufficient strength to prevent deformation by ordinary handling.

FIG. 8 is a cross-section view of the 30-lb., M 5, fragmentation bomb which represents the latest design of this type. Since a fragmentation bomb is designed for use primarily against exposed personnel, the double requirement which exists for demolition bombs, namely, that they shall produce damage primarily by blast and secondarily by fragments, is reduced to the single requirement in the case of fragmentation bombs, namely, that they shall produce destruction as a result of fragmentation of the bomb case. This result is obtained by so proportioning the explosive filler and metal parts of the bomb, that, on detonation, the bomb case is broken up into uniform fragments and these fragments projected with high velocities. An effective fragment is assumed to be one which will disable personnel. It weighs approximately 0.2 oz. and has sufficient velocity to penetrate a ¾-inch spruce board. The amount of explosive in a fragmentation bomb is approximately 15 per cent of the total weight of the bomb, while a demolition bomb contains about 50 per cent explosive charge. Early designs of fragmentation bombs used the forged or cast steel one-piece body, which resulted in rather erratic fragmentation effect. By grooving the casting an increase in uniformity of fragments would result but the slight increase would be more than offset by the added cost. An effective solution of the problem was found in a design which called for a built-up body using rings cut from tubes. The present method of manufacturing this bomb is to cut the rings from standard seamless drawn steel tubing. The rings are assembled over an inner tube and held in place by nose and tail steel castings. There are several methods of manufacturing the rings which could be used in an emergency. Tests of the 30-lb. M 5 bomb indicate more uniform fragments and greater fragmentation effect than any bomb previously designed. This bomb, with metal parts weighing 25.8-lbs., breaks up into approximately 1,400 fragments weighing an average of .27 oz. The 25-lb. Mk. III bomb of war-time design with metal parts weighing 19-lbs. breaks up upon detonation into approximately 500 fragments weighing .15 oz.

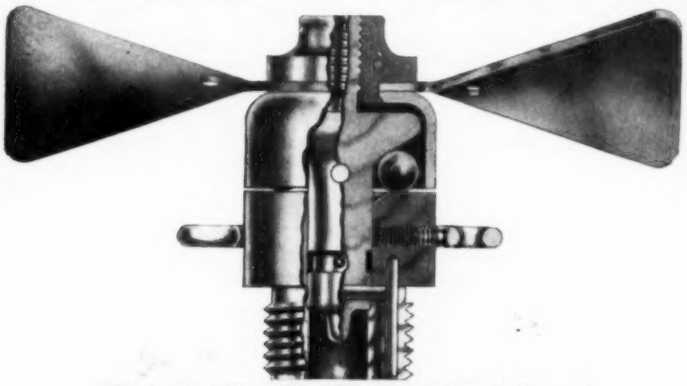


Fig. 4. Nose Fuze Mk. XIV, for Fragmentation and Small Chemical Bombs.

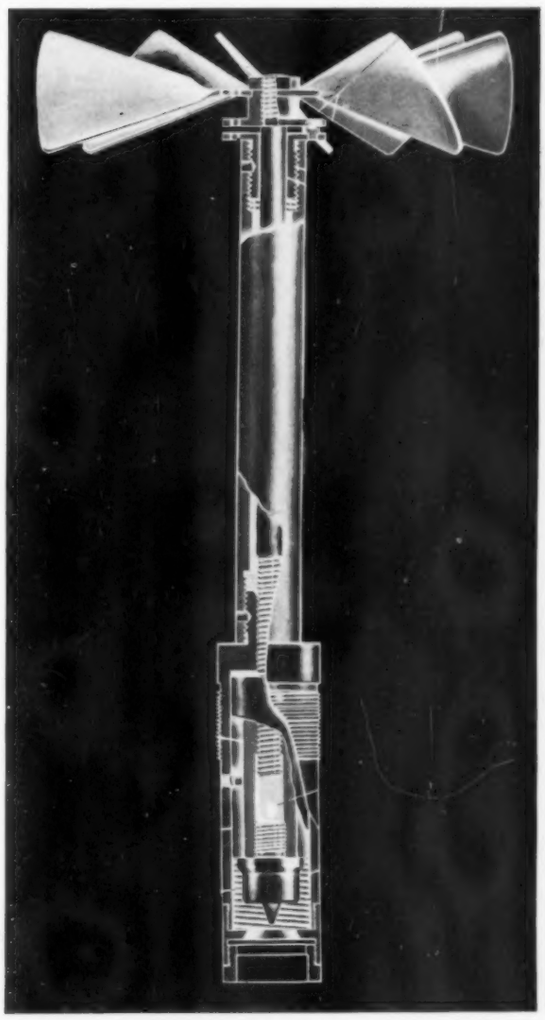


Fig. 5. Tail Fuze, Mk. V MI, for Demolition Bombs.

Fig. 10 shows the various steps in the manufacture of the body for the 30-lb. chemical bomb. The blank used is standard commercial seamless drawn steel tubing. The manufacture of this bomb is very interesting, particularly the spinning operation which consists of the closing in of the end of the tube to a semispherical shape to form the bossed or rear end of the bomb body. This operation is performed in a special machine known as a spinning machine, from

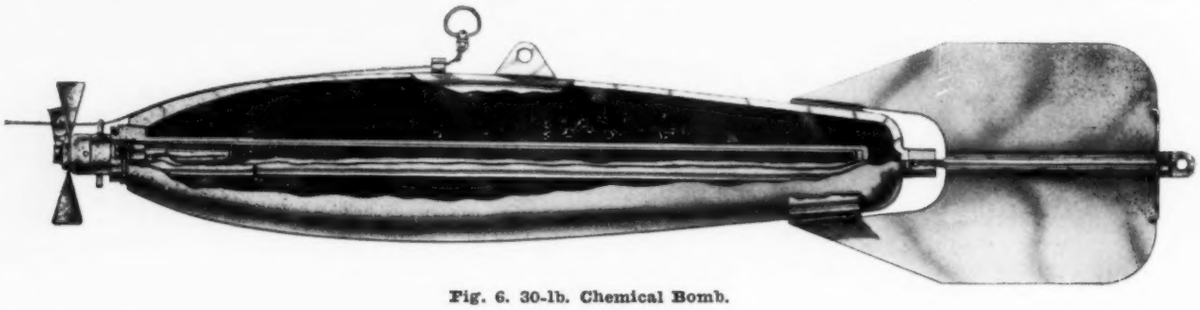


Fig. 6. 30-lb. Chemical Bomb.

the fact that it is designed to rotate or spin the tube on its longitudinal axis at a high rate of speed. The work of closing the bottom is done while the tube is spinning. The tube is heated to a suitable length before being placed in the chuck of the spinning machine. In closing the tube, the friction caused by contact of the tool with the heated walls generates sufficient heat in the metal to produce a welding temperature at the point where the two walls come together. The passing of the tool across the end of the tube, under pressure, completes the welding action and the walls are thus closed and welded into a solid bottom.

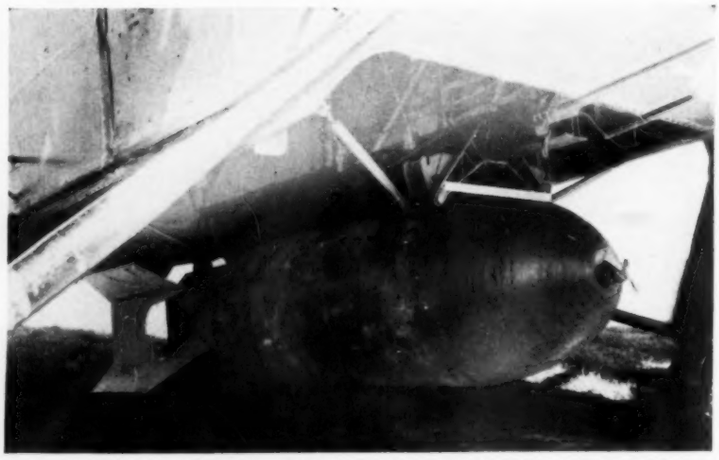


Fig. 7. 2,000-lb. E IV Demolition Bomb (Experimental) Attached to Type H-4 Bomb Rack on XLB-2 Airplane.

ALL standard demolition bombs are equipped with two fuzes, one in the nose and one in the tail. This is to insure functioning of the bomb in case one fuze fails and is not, as is commonly supposed, for the purpose of obtaining better detonation by detonating the bomb at both ends. It is very seldom that the two fuzes function simultaneously, and either fuze is sufficient to cause complete detonation of the explosive charge. However, since the cost of the additional fuze is a very small percentage of the cost of the complete bomb the use of the extra fuze is fully warranted.

The present standard nose fuze for demolition bombs, up to 1100-lbs. in weight, is the Mk. VII M1 shown in Fig. 3, while the standard tail fuze is the Mk. V MI shown in Fig. 4. The same type fuzes in larger sizes are used with the 2000-lb. bomb. These fuzes are very simple and reliable and result in practically 100 per cent functioning of the bomb either on water or land impact. Both instantaneous and delay action primer-detonators are furnished for use with the fuzes so that either instantaneous functioning or delay of detonation after impact can be obtained, depending on the type of target against which the bombs are used. For instance, an instantaneous primer-detonator would be used if the target were an ammunition dump, while delay action would be desired in a bomb dropped on a factory. All bomb fuzes are designed so that the bomb can be dropped "armed" or "safe" by the bomber. That is, the fuzes are made operative or inoperative when the bomb is released resulting in functioning of the bomb or a dud. This is desirable so that if for any reason it is necessary to drop the bombs over friendly territory or from very low altitudes they can be released in such condition that they will not function on impact. This is accomplished by means of an arming wire which has one end threaded through the arming vane, or spinner of the fuze, while the other end, formed in a loop, is inserted in the arming device of the bomb rack. If it is desired to drop the bomb "safe"

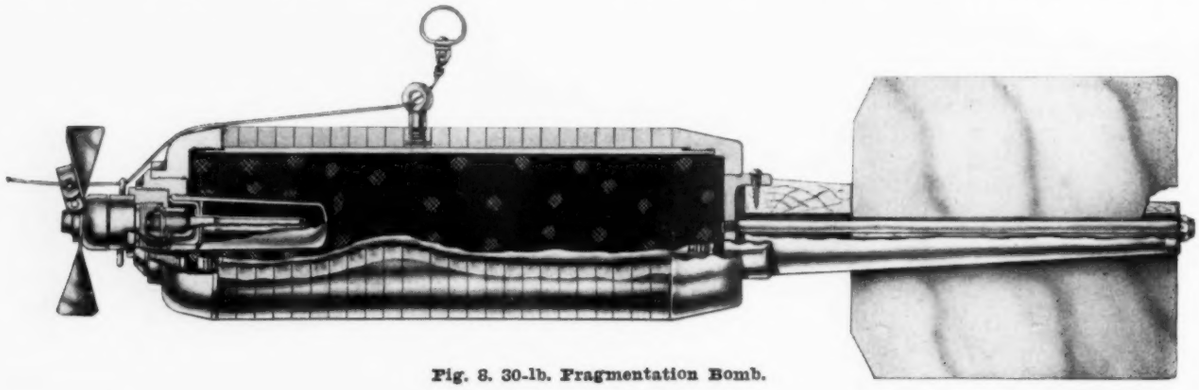


Fig. 8. 30-lb. Fragmentation Bomb.

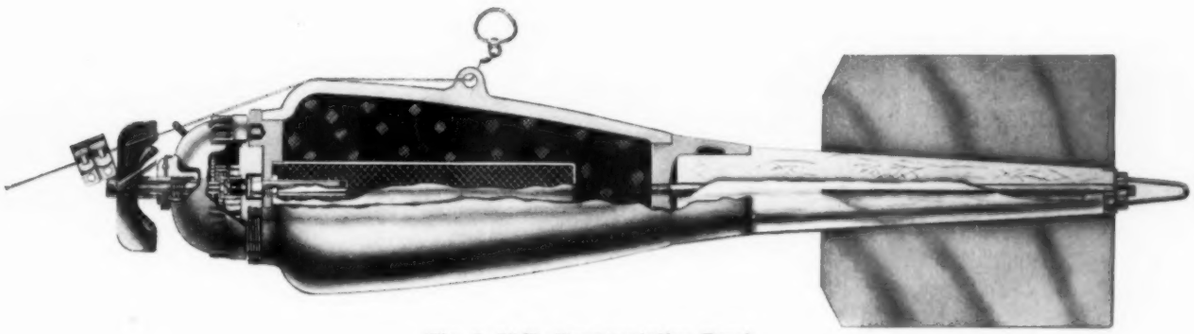


Fig. 9. 25-lb. Fragmentation Bomb.

the arming lever in the bomber's cockpit is moved to the safe position. This allows the arming wire to be released from the bomb rack with the bomb and thereby prevents the arming vanes from turning during flight of the bomb. If it is desired to drop the bomb "armed" the lever is moved to armed position which causes the loop end of the arming wire to be locked in the arming device of the bomb rack. When the bomb is then released the arming wire is retained with the bomb rack and is withdrawn from the fuzes thus allowing the arming vanes to turn and arm the fuzes.

By referring to Fig. 3 the operation of the Mk. VII MI nose fuze when dropped safe or armed may be understood. When dropped safe the arming wire remains in the fuze and prevents the arming vane from turning. Thus the steel discs between the pressure plate and fuze body are retained by the arming vane cup. The pressure plate and firing pin form one assembly. Thus on impact any movement of the firing pin relative to the primer is prevented. The force is transmitted from the pressure plate through the steel discs and fuze body to the bomb case. When dropped armed the arming wire is retained by the bomb rack and is therefore withdrawn from the fuze when the bomb is released. The arming vane starts turning immediately, and after about fifteen turns spins entirely free of the fuze. The steel discs are thus released and are forced out from under the pressure plate by a flat steel spring which is pinned to two adjacent discs. During the remainder of the flight of the bomb the firing pin is held off the primer by a small brass shear wire which passes through the body of the fuze and the firing pin. On impact the force is exerted on the pressure plate which shears the small brass wire, and the firing pin pierces the primer. The flash from the primer ignites the delay element (if any) and in turn the detonator, booster and explosive filling charge.

The Mk. XIV fuze shown in Fig. 5 is similar in construction and operation to the Mk. VII MI. It is smaller and contains steel balls instead of steel discs between the pressure plate and fuze body. This fuze is used for fragmentation and small smoke bombs.

Fig. 4 is a cross-section view of the Mk. V MI tail bomb fuze, which is the type used in all standard demolition bombs. The operation of the fuze is very simple and may be followed by referring to the illustration. When the bomb is released to detonate on impact, the arming wire is retained in the arming device of the bomb rack, and is thus withdrawn from the arming vane assembly, which immediately begins to spin due to the relative rush of air past the bomb. The arming vane and arming vane stem are permanently assembled as one piece, and constitute the arming vane assembly. As it spins, the stem unscrews from the firing pin weight after about twenty turns. The fuze is now armed, the firing pin weight being free to move toward the primer except for the resistance of the firing pin spring. The arming vane continues to spin and after about fifteen more turns required for the arming vane stem to unscrew from the threaded portion of the arming vane stem guide, the arming vane assembly is carried away from the bomb by the resistance of the air. On impact, the bomb is suddenly retarded, upon which the firing pin weight, due to its inertia, travels forward relative to the firing pin sleeve. The firing pin hits the primer which causes the successive functioning of the primer, delay element (if any), detonator, booster, and explosive charge.

If it is desired to drop the bomb in the safe condition the arming wire is allowed to fall with the bomb. This prevents the rotation of the arming vane during the whole of the downward flight. Upon impact, the firing pin weight is held in the rearmost position by the arming vane assembly, the primer is not struck and the bomb is not detonated.

A special safety feature of the Mk. V MI fuze is as follows: The inside of the firing

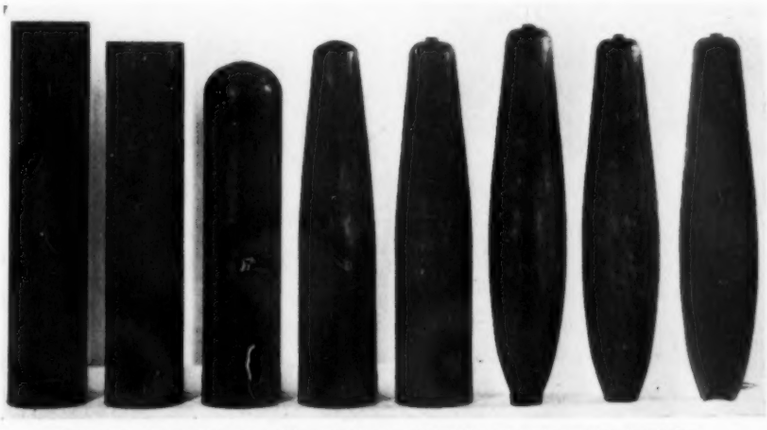


Fig. 10. Operations in Manufacture of 30-lb. Chemical Bomb Body.

Left to right: 1. Blank-standard seamless drawn steel tube; 2. Nose end upset; 3. Tail end closed by spinning operation; 4. Tail end swaged to streamline form; 5. Boss for attaching fin assembly formed on tail end; 6. Nose end swaged to streamline form; 7. Excess metal removed from nose end; 8. Completed body sectionalized.

pin sleeve is provided with threads through which the arming vane stem screws before being screwed into the firing pin weight. This prevents the driving of the firing pin weight toward the primer by any accidental blow on the arming vane while the stem is wholly or partially unscrewed.

IN an attempt to overcome certain objectionable features of the Mk. VII MI nose fuze and the Mk. V MI tail fuze with the accompanying assortment of primer-detonators, projects have been initiated to develop all-purpose nose and tail fuzes containing several new and novel features in bomb fuze design. The so-called "bore-safe" principle, in which the detonator is out of line with the explosive train and cannot possibly cause functioning of the explosive charge when the fuze is set at "safe," has been successfully used in artillery ammunition. This principle is being incorporated in the design of the new nose fuze for demolition bombs. This fuze will also contain a simple setting arrangement whereby the optional setting for instantaneous or short delay action can be made in the field either before or after the fuze has been inserted in the bomb. Thus the necessity for the objectionable primer-detonators will be eliminated. The fuze will be designed to allow interchangeability in all size demolition bombs from the smallest to the largest.

The new type tail fuze will be of much more simple construction than the nose fuze, mainly because the tail fuze is not subjected to the tremendous crushing forces at impact that tend to flatten any nose fuze and even the nose section of the bomb case. The tail fuze will therefore not contain the bore-safe feature. It will provide for only short delay fuze action, and the construction and operation will be similar to the present Mk. V MI fuze. The primary function of the tail fuze will be to provide certainty of action in case the nose fuze fails. Like the nose fuze it will be so designed as to allow interchangeability in all size demolition bombs.

The tactics of attack aviation, which provide for the operation of that branch of the Air Corps at extremely low altitudes (about 25-ft.), prohibits the use of an ordinary fragmentation bomb with instantaneous fuze. When dropped from this altitude with the airplane in horizontal flight a stabilized bomb will not strike the ground nose on, upon which the functioning of the present type bomb fuzes depends. Therefore an all-ways fuze, which will function no matter in what position the bomb strikes the ground, is necessary for extremely low altitude bombing. Since this type fuze is required the necessity for fins to stabilize the bomb is eliminated. The fuze must provide for a comparatively long delay of detonation after impact to allow the airplane, from which the bomb is dropped, to be at a safe distance before functioning of the bomb occurs. Reliable all-ways fuzes with five second delay elements have been developed for this purpose. Several types of unstabilized low altitude fragmentation bombs have been tested. One of these types with modifications will be manufactured in small quantities for test by the Air Corps.

WHILE cost is an important factor affecting the design of any type of ammunition, availability of raw materials and the ease with which commercial concerns with their present or slightly modified facilities could manufacture the item in case of an emergency are carefully studied before the design is approved. Not only must the design of metal parts be according to standard commercial practice, but it must be such that assembly into the complete article and loading with explosive can be easily and economically accomplished. The explosive filling charge for bombs is usually TNT which is first melted in steam-jacketed kettles and poured into the bomb body. The opening through which this loading is done must be of a certain minimum size in order that the explosive may be properly poured and must also be of a certain shape so that cavities in the explosive charge due to trapped air will not result.

The future bombardment airplane with its complement of bombs and machine guns will be an extremely efficient offensive and defensive weapon for warfare. It will be equipped with several machine guns for defense against enemy aircraft. These guns will be flexibly mounted at various positions on the airplane so as to avoid "blind angles." In other words, no matter from which direction an enemy aircraft approaches for attack, at least one gunner will have an unobstructed view for defense. With a large number of these airplanes flying in formation it can be seen that the combined volume of fire that can be concentrated on attacking aircraft is tremendous. The bombardment airplane may be capable of flying at extremely high altitudes so as to be beyond the effective range of antiaircraft fire from the ground.

The type and size of bombs carried will depend on the mission to be accomplished. If an ammunition dump, railroad yards or targets of light construction are to be attacked, 100-lb. demolition bombs with instantaneous fuzes probably will be used. If the target is a bridge of concrete or steel construction or factories of heavy construction, 1100-lb. or even 2000-lb. demolition bombs with delay action fuzes probably would be used. The present bombardment airplane can carry twenty 100-lb., six 300-lb., four 600-lb., two 1100-lb. or one 2000-lb. bomb. All of these bombs, except the 2000-lb., are carried inside the fuselage of the airplane. That is, the bomb rack is built into a large compartment, the bottom of which is open. Internal suspension of bombs is more desirable than external suspension due to the reduction in head resistance with the resultant increase in lifting capacity. The 2000-lb. bomb must be carried on an external rack because the length of the bomb makes it impracticable to provide an unbraced compartment this size inside the fuselage. The future airplane of this type will be capable of carrying at least twice this weight of bombs to much greater distances. The bomb sight will be a very accurate instrument which can be operated by a comparatively inexperienced man. All the bomber will be required to do will be to keep the instrument pointed at the target. In other respects the instrument will be automatic. That is, it will indicate automatically to the pilot by means of a pointer whether the ground course of the airplane is in line with the target. At the proper instant a contact will be made which, through an electrical release mechanism, will drop the bomb.

When one considers the increased efficiency, or destructive effect of bombs, the increased accuracy of bombing even from extremely high altitudes, and the rapid strides made in development of aviation during the past few years, it can be realized that bombing is destined to have an extremely important part in any future national emergency.

Army Ordnance Association, Inc.

Directors at Annual Meeting Transact Important Business

THE regular annual meeting of the Officers and Directors of the Army Ordnance Association was held in New York City, January 24, 1929. The most noteworthy business transacted was that accomplishing incorporation of the Association under the laws of the District of Columbia. The submission of reports on the status of the organization and the passage of important resolutions also marked the transactions.

The Board at its meeting in 1928 considered the advisability of incorporating the Association. In the interim the matter was studied very carefully and it was decided that the corporate form has many advantages. The method by which the transition was effected is explained fully in the following minutes of the meeting.

It will be noted that a new Constitution and By-laws were necessary to conform to the new legal status. In the new form the entire organization remains substantially the same as before incorporation. All officers of the uncorporated association hold the same positions in the incorporated organization with the exception of the Counsel, John Ross Dalefield, who succeeds Henry L. Stimson in this office. In amending the Constitution provision was made for life membership—a class which has not existed heretofore.

The Directors adopted resolutions authorizing the acceptance of endowments and also went on record in favor of the Cramton Bill (H. R. 15173), now before Congress, to establish uniform requirements affecting Government contracts.

For the information of members of the Association the minutes of the meeting, including the annual report of the Secretary for the year 1928, follow:

Minutes of a Meeting of the Directors,
Army Ordnance Association

HELD at 100 East 42nd Street in the Board Room of the American Exchange Irving Trust Company, in the Borough of Manhattan, City of New York, on the 24th day of January, 1929, at 11 o'clock in the forenoon.

There were present:

Benedict Crowell, President
William W. Coleman, Vice-President
William C. Spruance, Vice-President
James L. Walsh, Director
John C. Jones, Director
Chas. Elliot Warren, Treasurer
Chas. R. Baxter, Secretary,

being a quorum of the Board of Directors. There were also present by invitation of the Board: John Ross Delafield, Henry P. Erwin, and L. A. Codd, members of the Association.

The President called the meeting to order and the Secretary was about to read the minutes of the last meeting. On motion duly made, seconded and carried, the reading of the minutes was dispensed with and they were approved as recorded.

The annual report of the activities and affairs of the Association for the calendar year ended December 31, 1928, was read by the Secretary. The report of the Secretary follows:

I HAVE the honor to submit the following report of activities and affairs of the Army Ordnance Association for the calendar year ended December 31, 1928, together with statements of the financial condition at that time.

"Constant effort was made during the year toward further improvement of ARMY ORDNANCE both as to text matter and typographical arrangement. The average size of the journal was 76 pages and cover, while the average press run for each issue was 4,400 copies.

"In an effort further to stimulate interest in the publication, arrangements have been concluded for three new front cover designs incorporating some of the well known lithographs of the late Joseph Pennell. It is felt that the new appearance of the journal beginning with the January-February, 1929, issue will add materially to its attractiveness.

"With the continual rise in membership of the Association and consequent greater circulation of the journal, together with the improvements already referred to, it is believed that the journal will increase in value as an advertising medium and that its subscription list also will grow.

"The Tenth Annual Meeting of the Association was held at the Aberdeen Proving Ground, Maryland, Thursday, October 4th, with the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Association of Military Surgeons of the United States, and the Construction Division Association participating. For the first time in the history of the Association the actual attendance was counted as visitors entered the Proving Ground, the dials showing that 10,048 people were present. Under the direction of the Quartermaster General of the Army approximately 4,700 meals were served.

"As in previous years, in addition to a preliminary announcement, a final program also was printed and distributed among the guests at the meeting.

"From every viewpoint the meeting was the most successful in the history of the organization. Not only was the attendance larger than in any previous year but nearly every detail was well planned and executed.

"The program of demonstrations by the Ordnance Department and other branches of the Army featured by a spectacular exhibition by the Air Corps was the most interesting and instructive yet held. The details connected with the handling of the huge crowds were admirably made and carried out, while the meals service reflected great credit upon the Quartermaster Corps and particularly upon the personnel of Fort Hoyle, Md., under Capt. R. C. Bower, who was in charge.

"The size of the crowd again made necessary the use of two special trains in the Proving Ground proper. As in the past, there were special overnight trains from New York, Pittsburgh, and New Haven and other New England cities and cars and busses from other points.

"In my estimation one of the marked improvements of the meeting was the technical session of the Association, presided over by the President, at which addresses were given by Maj. Gen. C. C. Williams, Chief of Ordnance, and James L. Walsh, Chairman, National Defense Division, American Society of Mechanical Engineers. Moving pictures of the various demonstrations were made and are being used, through Association headquarters, by our various local posts and other interested organizations.

"The Association is under a deep debt of gratitude to the War Department for its splendid coöperation in every detail of the meeting. To General Williams and the Officers of the Ordnance Department I cannot give adequate praise. Col. C. M. Wesson, Commanding Officer at the Proving Ground, and the officers of his staff made every possible arrangement for an interesting program and for adequate provisions for the large attendance. In addition to the Quartermaster Corps and other branches of the Army, we are particularly grateful to the Assistant Secretary of War, Hon. F. Trubee Davison, who made possible the Air Corps demonstration which attracted great interest.

DURING 1928 one new local post was organized and chartered. Through the personal efforts of our First Vice-President, Col. Wm. W. Coleman, a post was organized in Milwaukee, the inaugural meeting of which was held on November 23rd. The Milwaukee Post has a membership of 65.

"The Association now has ten local posts including, in addition to that of Milwaukee, New York (membership 242), California (membership 144), Chicago (membership 71), Boston (membership 101), Washington (membership 66), Cincinnati (membership 90), Philadelphia (membership 177), St. Louis (membership 110), and Pittsburgh (membership 171). The total number of members affiliated with local posts is 1,237, or approximately 36 per cent of the total Association membership of 3,386. It is the aim of the Secretary to foster the establishment of local posts wherever sufficient interest is displayed, and it is hoped that arrangements can be perfected for the establishment of other posts, particularly in our larger industrial centers.

"During 1928 there was a net increase in members of 133. The gross increase was 537, while 404 old members, by resignation, death, and nonpayment of dues, were dropped from the roster. The percentage of members dropped is lower than that of previous years. The total membership, all classes, as of December 31, 1928, is 3,386, the largest membership in the history of the Association.

"On September 6, 1928, the Constitution of the Association was amended in the regular way changing the qualifications of junior members. Under the amended clause junior membership is open to 'all men who are American citizens and who are students in technical schools or colleges.' It is believed that this provision will aid very materially in increasing the number of junior members. During 1928, 12 new group members were enrolled, while 6 group members resigned.

THE Ordnance trophy, a caliber .22 Sport Model Springfield Rifle, for award to the winner of the President's Match of the National Rifle Matches, was awarded to Sgt. H. R. King, U. S. M. C. Two prizes of $50 each were awarded to members of the First Class, U. S. Military Academy, for the best papers submitted on an ordnance subject suitable for publication in ARMY ORDNANCE. The winner of the first prize was Cadet D. C. McNair for a paper entitled, 'Erosion of Rifled Bores.' The second prize was awarded jointly to Cadets Church M. Matthews and R. C. Wilson, for a paper, 'The Sword: From Combat to Ceremony.' Both papers were published in the November-December issue of ARMY ORDNANCE.

"An audit of the finances of the Association, under the direction of Col. Lester W. Blyth, was made by Messrs. Ernst & Ernst, certified public accountants, as of December 31, 1928. The audit covered the fiscal year 1928. The accounts of the Association were found to be correct and in good order.

"The balance sheet of December 31, 1928, as approved by the auditors is as follows:

BALANCE SHEET
Army Ordnance Association

Assets

	1928	1927
Cash on hand	$ 2.69	$ 21.48
Cash on deposit:		
Association Account	5,811.28	7,430.31
Magazine Account	3,252.43	3,932.46
Demonstration Fund	400.00	303.33
Accounts receivable:		
Due from advertisers	90.00	270.00
Other Assets:		
Securities owned	21,939.85*	15,196.91
Postage	73.14	39.15
Permanent		
Furniture, fixtures and supplies	1.00	1.00
Total	$ 31,570.39	$ 27,194.64

Liabilities

Unearned Income:		
Prepaid membership dues	$ 9,816.92	$ 7,982.76
Prepaid subscriptions to magazine	756.00	626.72
Operating Reserve	20,997.47	18,585.16
Total	$ 31,570.39	$ 27,194.64

*Cost. Market value December 31, 1928, $22,243.80.

(Here follow detailed items of expected income and an itemized statement of the budget of expenditures for 1929.)

"By a decision of the Collector of Internal Revenue the Association is exempt from the payment of income tax and contributions to the Association by individuals are deductible for income tax purposes.

AT the annual meeting of the Board of Directors in February, 1928, General Delafield was requested to investigate and take the necessary steps toward incorporating the Association. General Delafield has given very graciously of his time during the past year in investigating this subject and is now prepared to recommend the necessary procedure for incorporation. I have requested General Delafield to be present at this meeting and to explain and conduct the necessary formalities.

"I feel that the Association, after ten years of operation, has evolved an ideal arrangement for conducting its affairs. Whatever recommendations I have to offer can be embodied in the suggestion that the method of operation as now conducted be continued. This applies particularly to executive headquarters and also to the affairs of the Finance Committee which, under resolutions approved by this Board last year, has the necessary authority to invest and withdraw surplus funds of the Association in invested securi-

ties as conditions arise. Colonel Warren, as Treasurer of the Association and as Chairman of the Finance Committee, is most gracious in his coöperation in all financial matters.

"In closing I would like to thank all officers and directors for their interest and coöperation of the past year. I have every reason to believe that the Association has a very promising future.

"Respectfully submitted,

CHAS. R. BAXTER,
Secretary."

After discussion the report was approved as read.

The Treasurer thereupon submitted his report for the fiscal year 1928 and presented the same to the meeting, and on motion duly made, seconded and carried, it was unanimously resolved, that the same be accepted and placed on file.

The Chairman thereupon called for reports of officers and committees.

James L. Walsh moved the following resolution which was duly seconded by William W. Coleman and unanimously carried:

WHEREAS, at the regular annual meeting of the Board of Directors of this Association held in New York City on February 16, 1928, this Board discussed the desirability of incorporating this Association and tentatively determined to do so, and thereafter Brig. Gen. John Ross Delafield, a member of the Association, was requested to investigate the matter and take the necessary steps to accomplish the same; and

WHEREAS, the said John Ross Delafield, Henry P. Erwin, and L. A. Codd, all members of the Army Ordnance Association, have executed and filed a charter and certificate of incorporation with the Recorder of Deeds in the District of Columbia, establishing the Army Ordnance Association in accordance with the laws of said District;

RESOLVED, that the said certificate of incorporation and charter be adopted as the charter for this Association, and that the necessary steps be taken forthwith to merge the present Association into said Army Ordnance Association as so incorporated, and that all the members and officers of this Association be duly and properly transferred to corresponding positions in said corporation, and that all the assets and properties of this Association be assigned and conveyed to said corporation upon the express assumption by said corporation of all the debts, contracts and liabilities of this Association, and that the officers of this Association be and they hereby are authorized to execute in the name of this Association all instruments necessary or required to transfer such assets, and do all other acts in the name of this Association necessary or required to accomplish this resolution and it intent.

There being no further business and on motion duly made and seconded the meeting adjourned.

(Signed) CHAS. R. BAXTER,
Secretary.

The transactions thereupon proceeded as follows:

Minutes of the Meeting of Incorporators
Army Ordnance Association

HELD at 100 East 42nd Street in the Board Room of the American Exchange Irving Trust Company in the Borough of Manhattan, City of New York, on the 24th day of January, in the year 1929, at 11:45 o'clock in the forenoon, for the purpose of perfecting the organization of this Association and the transaction of such other business as may properly come before the subscribers.

There were present:

John Ross Delafield
Henry P. Erwin
L. A. Codd,

being all of the incorporators and subscribers to the certificate of incorporation.

Colonel Erwin called the meeting to order and on motion duly made and seconded General Delafield was made and elected Chairman of the meeting, and on motion duly made and seconded Captain Codd was made and elected Secretary of the meeting.

General Delafield then took the chair.

The Secretary reported that the charter and certificate of incorporation was recorded in the office of the Recorder of Deeds of the District of Columbia on the 21st day of December, 1928, and then presented a certified copy of said charter and certificate of incorporation to the meeting.

On motion duly made, seconded and carried it was unanimously

VOTED that a copy of said original charter and certificate of incorporation be spread at length on the minutes. It is as follows:

CERTIFICATE OF INCORPORATION
OF
ARMY ORDNANCE ASSOCIATION

WE, the undersigned, citizens of the United States, of full age, a majority of whom are citizens of the District of Columbia, desiring to form a corporation pursuant to and in conformity with the Code of Laws of the District of Columbia, do hereby certify:

First: The name of the Corporation shall be ARMY ORDNANCE ASSOCIATION.

Second: The Corporation shall have perpetual existence.

Third: The particular business and objects of the Corporation are:

To assist in effecting industrial preparedness for war as being one of the Nation's strongest guarantees of peace, and to that end:

To keep available the highly specialized knowledge necessary for arming the manhood of the Nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the Nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

In pursuance of and not in limitation of the general powers conferred by law, and the objects and purposes

herein set forth, it is expressly provided that this Corporation shall also have the following powers:

To do all such acts as are necessary or convenient to attain the objects and purposes herein set forth, to the same extent and as fully as any natural person could or might do, and are not forbidden by law or by this Certificate of Incorporation or by the Constitution or By-laws of this Corporation;

To purchase, lease, hold, receive by gift, devise or bequest, sell, mortgage, or otherwise acquire or dispose of real or personal property, to enter into, make, perform and carry out contracts of every kind with any firm, person, corporation or association;

To have offices and promote and carry on its objects and purposes within or without the District of Columbia, and in other states, territories or colonies of the United States;

To have all powers that may be conferred upon a Corporation by the Laws of the District of Columbia except as prohibited by the Constitution or By-Laws of this Corporation.

Fourth: The property of the officers and that of the members of this Corporation shall not be subjected to or chargeable with the payment of the corporate debts or obligations.

Fifth: The membership of the Corporation may be grouped by localities, wholly or in part, in suborganizations designated "Local Posts" of the Army Ordnance Association, which are to be formed under such regulations as may be prescribed, from time to time, by the Board of Directors.

Sixth: The Board of Directors shall have power to make By-laws for the government of the Corporation and to alter, change or amend the same.

Seventh: The meetings of the members and of the Directors of this Corporation may be held in the District of Columbia, or elsewhere within the confines of the United States or in its possessions.

Eighth: The number of Trustees of the Corporation for the first year shall be seven (7).

Witness our hands and seals this 18th day of December, in the year of our Lord, one thousand nine hundred and twenty-eight.

JOHN ROSS DELAFIELD (L. S.)
HENRY P. ERWIN (L. S.)
L. A. CODD (L. S.)

District of Columia, to wit:

I, John A. Colborn, a Notary Public in and for the District of Columbia, do hereby certify that Henry Parsons Erwin, L. A. Codd and John Ross Delafield, parties to the annexed and foregoing Certificate of Incorporation of the Army Ordnance Association, dated December 18th, 1928, personally appeared before me in said District, the said Henry Parsons Erwin, L. A. Codd and John Ross Delafield, being personally well known to me as the persons who executed said Certificate of Incorporation, and acknowledged the same to be their act and deed.

Given under my hand and seal this 20th day of December, 1928.

(Notarial Seal) JOHN A COLBORN,
Notary Public.

My commission expires October 23, 1929.

Colonel Erwin then proposed and nominated the following persons for membership in the Association and such nominations were thereupon each and all duly seconded by Captain Codd:

Benedict Crowell, of Cleveland, Ohio.
William W. Coleman, of Milwaukee, Wis.
William C. Spruance, of Wilmington, Del.
James L. Walsh, of New York, N. Y.
John C. Jones, of Philadelphia, Pa.
Chas. Elliot Warren of New York, N. Y.
Charles R. Baxter, of Washington, D. C.

On motion duly made, seconded and unanimously carried it was

VOTED that the Secretary be and he hereby is directed to cast one ballot for all of the persons so nominated for membership.

The Secretary thereupon cast such ballot and reported that he had done so and that all the persons nominated had been duly elected and had become members of the Association.

The Chairman then declared the next business to be the election of officers and directors to serve until the next annual election or until their successors were duly elected.

The following were thereupon duly nominated:

For President, Benedict Crowell.
For Vice-President, William W. Coleman.
For Vice-President, William C. Spruance.
For Treasurer, Chas. Elliot Warren.
For Secretary, Chas. R. Baxter.

For Directors:

(*Term to expire December 31, 1932*)

Robert P. Lamont
Frank A. Scott
Charles L. Harrison

(*Term to expire December 31, 1930*)

Waldo C. Bryant
Samuel McRoberts
Pliny E. Holt

(*Term to expire on the same dates as their respective directorships would have expired in said unincorporated Army Ordnance Association*)

Bruce Cornwall
Spencer G. Kuhn
Charles H. Tenney
Harry Scullin
Ralph M. Dravo
John C. Jones
James L. Walsh

There being no further nominations and on motion duly made, seconded and unanimously carried it was

VOTED that the Secretary be and he hereby is directed to cast one ballot for each of the persons so nominated for the office to which he was nominated.

The Secretary thereupon cast such ballots and reported that all of said persons had been duly elected to the offices for which they had been nominated.

The President then took the chair and the other officers assumed the duties of the offices to which they had been elected.

THE Secretary then presented a form of constitution and by-laws for the regulation of the affairs of the Association which were read, article by article, and on motion duly made and seconded they were unanimously adopted and ordered to be inserted at length on the minutes. They are as follows:

Constitution

Article I

Name

Sec. 1. The name of the organization shall be ARMY ORDNANCE ASSOCIATION.

Sec. 2. The executive offices of the Association shall be in the City of Washington, District of Columbia.

Article II

Objectives

Sec. 1. The objectives of the Army Ordnance Association, hereinafter referred to in this Constittuion and in the By-laws as the Association, shall be:

To assist in effecting industrial preparedness for war as being one of the Nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve Officers of the Army Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the Nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

Sec. 2. In the accomplishment of these objects the Association shall have all the powers set forth in the Certificate of Incorporation and granted to it by Subchapter III, Chapter XVIII, of the Code of Laws of the District of Columbia.

Article III

Membership

Sec. 1. Full membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of Ordnance material.

Sec. 2. Life membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of Ordnance material.

Life membership shall continue during the lifetime of the life member and shall expire at death. It shall not be transferrable.

Sec. 3. Student membership in the Association shall be open to all men who are American citizens and who are students in technical schools or colleges. Student members shall not vote or hold office in the Association.

Sec. 4. Group membership in the Association shall be open to all individuals, firms, companies and groups controlled by American citizens who are interested in promoting the cause of industrial preparedness particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of Ordnance material.

Group members shall have the privilege of nominating ten men for full membership in the Association, and members thus nominated shall pay no dues. Group members shall also be entitled to a quarter page advertisement in ARMY ORDNANCE, the journal of the Army Ordnance Association, during the term of said group membership. Group members who avail themselves of this latter privilege must submit all copy for publication to the Editor of ARMY ORDNANCE for approval.

Sec. 5. Honorary membership for life shall be conferred, in the discretion of the Board of Trustees, upon persons who have rendered meritorious service to the cause of industrial preparedness. Honorary members shall be entitled to all privileges of full membership except as otherwise provided in this Constitution and in the By-laws.

Sec. 6. The term "member" when hereafter used in this Constitution and in the By-laws shall mean full and life members only.

Sec. 7. Nothing in this Article shall be construed to change the existing status of any Junior or Associate members of the Association, but all members hereafter admitted to membership in the Association or any Post thereof shall conform to the classifications above defined.

Article IV

Officers, Board of Directors and Board of Trustees

Sec. 1. The government of the Association shall be vested in its officers, a Board of Directors and a Board of Trustees.

Sec. 2. The officers shall consist of a President, a First Vice-President, and a Second Vice-President, who shall be elected by letter ballot of the members of the Association for a term of two calendar years, and a Counsel, a Treasurer, and an Executive Secretary who shall be elected by the Board of Trustees and who shall hold office for two calendar years or until their successors have been elected and qualified.

Sec. 3. The Board of Directors shall consist of the President, who shall be ex-officio chairman, the Vice-Presidents, one member elected by each duly authorized Post of the Association, and six members elected by general ballot of the members of the Association. The term of office of members of the Board of Directors elected by letter ballot of the Association shall be for four calendar years, provided that the term of three members thereof shall terminate December 31, 1930, and every four years thereafter, and of the remaining three December 31, 1932, and every four years thereafter. The Board of Directors shall have power to fill casual vacancies in the case of its members elected by general ballot and in the offices of President and Vice-Presidents.

Sec. 4. The Board of Trustees shall consist of the officers and one director to be appointed annually by the Board of Directors and shall act as the Board of Trustees required by the laws of the District of Columbia to have control and management of the affairs and funds of the Association.

Sec. 5. The Board of Directors shall prepare By-laws governing the Association which shall become effective when approved by a majority thereof.

Article V

Meetings

Sec. 1. The annual meeting of the Association shall be held in the autumn of each year, preferably during October, for the discussion of new and improved methods of manufacture, to witness the demonstration of such experimental types of ordnance material as may be authorized by the War Department, and for other purposes.

Sec. 2. The Association may hold such special meetings as may be necessary, to be called in the manner provided by the By-laws.

Article VI

Amendments

Sec. 1. Amendments to this Constitution may be proposed by a majority vote of the Board of Directors or of the Board of Trustees or upon petition addressed to the President and signed by not less than 5 per cent of the total number of members.

Sec. 2. Proposed amendments shall be submitted to the entire active membership by letter ballot and shall be adopted if a majority of the votes cast are in favor thereof.

Sec. 3. Voting shall cease and the polls close on amendments to the Constitution on a predetermined date not less than thirty (30) days after the ballots have been mailed to the members. The votes shall be counted by a committee of three tellers appointed by the President, and certified to the Executive Secretary within fifteen (15) days after the polls have closed.

Sec. 4. Amendments, unless otherwise provided for, shall become effective upon receipt of the Executive Secretary of a certificate of their adoption by the tellers.

By-Laws

Membership

1. The election to membership of all classes shall be entrusted to the Board of Trustees, and the decision of that Board as to eligibility shall be final.

2. Any person desiring to become a member shall make written application to the Executive Secretary, said application shall be in such form and contain such data as may be prescribed by the Board of Trustees.

3. Any member may withdraw from the Association at any time by tendering his resignation in writing, but such resignation shall not become effective until said member shall have paid all sums due the Association from him at the time of such resignation.

4. Any member may be dropped for cause by a vote of four (4) members of the Board of Trustees, or having been dropped may be reinstated at the discretion of the Board of Trustees.

Membership Dues

5. The fee for life membership in the Association shall be one hundred ($100.00) dollars. The annual dues for membership in the Association shall be, for Members, five ($5.00) dollars; for Student Members, two dollars and twenty-five cents ($2.25); and for Group Members, one hundred ($100.00) dollars, payable in advance. These sums are in addition to whatever dues or assessments may be imposed by the respective local posts in the case of members.

Board of Trustees

6. The Board of Trustees shall have control of the management, finances, publications and election of members of the Association, and, within the limitations of the Constitution, shall have the power to initiate and execute any measures whatsoever which in its judgment seem necessary or expedient to further the interests of the Association and achieve its objects. The Board of Trustees shall meet at least once a year and a majority of the members of the Board of Trustees shall constitute a quorum for the transaction of business.

Board of Directors

7. The Board of Directors shall have charge of the technical, scientific, and social interests and activities of the Association, and in regard to the business and financial interests it shall act in an advisory capacity and may delegate any of its duties other than in connection with amendments to the Certificate of Incorporation, Constitution or By-laws, to the Board of Trustees. The Board of Directors shall meet at least once each year and five (5) members thereof shall constitute a quorum.

Officers

8. The President shall have general supervision of the affairs of the Association; he shall preside at the meetings of the Association, of the Board of Directors and of the Board of Trustees; he shall be ex-officio a member of all committees and of all subcommittees thereof. In the absence of the President his duties shall devolve upon the Vice-Presidents in succession, and, in their absence, upon the Board of Trustees in order of seniority of service.

9. The Counsel shall be the legal adviser to the officers, the Board of Trustees and the Board of Directors.

10. The Treasurer shall be comptroller of the finances and accounts of the Association under the direction of the Board of Trustees. He shall render an annual report and such special reports as may be called for by the Board of Trustees. The accounts of the Association shall be audited annually by an auditing committee of three members to be appointed by the President, which committee shall report the result of such audit to the Board of Trustees, or in the discretion of the Board of Trustees a certified public accountant may conduct the annual audit, his report to be made to the Board of Trustees.

11. The Executive Secretary shall make collections and disbursements under the supervision of the Board of Trustees, shall keep the roster of members and the record of the status of annual dues, shall be the keeper of the seal of the Association and shall have custody of correspondence and records. He shall be responsible that suitable arrangements are made for the annual and other meetings of the Association, of the Board of Directors and of the Board of Trustees, the proceedings of which he shall record. He shall submit an annual report to the Board of Trustees for presentation to the Board of Directors at its annual meeting. He shall be responsible for the management of the executive offices and shall have the power to contract in the name of the Association for such services and supplies as are necessary for its operation.

Local Posts

12. Upon petition signed by not less than twenty-five (25) members of the Association in any locality stating their desire to form a local unit for the more intimate

achievement of the purposes of the Association, such unit to be known as a local post, the Executive Secretary of the Association shall immediately authorize a meeting for such inauguration and the Association shall contribute to the organizing expenses of such post the sum of two ($2.00) dollars for each such petitioner, such payment to be, however, not over one hundred ($100.00) dollars in the aggregate for any one city.

13. When not less than twenty-five (25) members of the Army Ordnance Association shall have enrolled as members of such a post, the Association shall issue a suitable charter thereto, signed by the President and Secretary of the Association.

14. Local posts shall be authorized to receive joint members into the Association and local post upon signed application for such joint membership containing the same pledge and statement of objective as contained in Army Ordnance Association membership application. The local post may collect annually whatever local dues may be assessed against its members, if any, plus five ($5.00) dollars annual dues to the Association, or if it so elect, the annual dues to the Association shall be collected by the Association in the usual manner. In either event, the sum of fifty (50¢) cents shall be remitted to each local post for each of its members upon the payment by them of their annual dues to the Association.

15. The Constitution of each local post shall be submitted to the President of the Association and shall be approved by him before the same shall become effective.

Amendments

16. Amendments to the By-laws may be made by the Board of Trustees at any regularly called meeting thereof.

Meetings

17. The annual meeting of the Association shall be held preferably during the month of October in each year. With the concurrence of the War Department the annual meeting will be held either at the Aberdeen Proving Ground, Maryland, or at a Government arsenal where current development, manufacture and test of war material may be exhibited and studied. The Board of Trustees shall determine the date and place of the annual meeting.

18. Special meetings of the Association may be called at any time at the discretion of the Board of Trustees or shall be called by the President upon written request of not less than 5 per cent of the total number of members, the notices for such meetings to state the business for which such meeting is called and no other business shall be entertained or transacted at that meeting.

19. Notice of each annual or special meeting shall be mailed by the Executive Secretary to each member not less than thirty (30) days before the date of that meeting.

Nominations

20. A Nominating Committee of five (5) members shall be appointed by the President on or before June 1st of each year in which elections are to be held. This Committee shall deliver to the Executive Secretary in writing on or before July 1st, the names of its nominees for the elective offices next falling vacant in the Association. The Executive Secretary will communicate with each nominee. In the case of the declination of any nominee to accept his nomination, the Executive Secretary shall report the fact of such declination to the Nominating Committee which will then nominate another member for the office.

21. Nominations also may be made by petition signed by not less than 5 per cent of the entire membership of the Association, which petition must be filed with the Executive Secretary together with the written acceptance of the nominations by the nominees, prior to July 20th.

Elections

22. The Executive Secretary shall mail on or before July 31st to each member entitled to vote a ballot stating the names of the candidates for the several offices falling vacant, and the time of the closure of the voting. The voter shall prepare his ballot by marking the same opposite the names of the respective candidates of his choice or by crossing out the name of any candidate or candidates rejected by him, and may write in the name of any eligible member of the Association. In no event shall the voter mark his ballot for more candidates than there are offices to be filled. The voter shall enclose ballot in an envelope and seal the same. He shall then enclose the sealed envelope in a second marked "Ballot for Officers," seal the same, and shall then write his name thereon for identification. The ballot thus prepared and enclosed shall be mailed or delivered unopened to the Executive Secretary of the Association.

Tellers

23. The President shall, on or before July 31st of each year in which elections are to be held, appoint three tellers of Election of Officers whose duty shall be to canvass the votes cast and certify the same to the President or Presiding Officer at the first subsequent session of the Board of Trustees. The term of office of the Tellers shall expire when their report of the canvass has been presented and accepted.

24. The Executive Secretary shall certify to the competency and signature of all voters, and shall deliver unopened all ballots to the Tellers of Election. Ballots without the endorsement of the voter written on the outside envelope are defective. Ballots which contain more names than there are offices to be filled are thereby defective, and shall be rejected by the Tellers of Election.

25. The voting for the election of officers shall close at 12 o'clock noon on the first Tuesday in September in each year. The Tellers shall not receive any ballot after the stated time for the closing of the voting. The Tellers of Election shall first open and destroy the outer envelopes and shall then open the inner ones, canvass the ballots and certify the result to the President or Presiding Officer at the next succeeding session of the Board of Trustees. The President or Presiding Officer shall then announce the candidates having the greatest number of votes for their respective offices and declare them elected for the ensuing term.

26. The names of the candidates proposed by the Nominating Committee and the names, if any, of members nominated by petition, and the respective offices for which they are candidates shall be printed in separate lists on the same ballot sheet.

27. In case of a tie in the vote for any officer, the President, or, in his absence, the Presiding Officer of the Board of Trustees, shall cast the deciding vote.

Calendar

28. The fiscal year shall close on December 31st of each year.

29. The yearly calendar shall be, where applicable, as nearly as possible as follows:

June 1 (on or before):

Nominating Committee of five members appointed by the President.

July 15 (on or before):

Nominating Committee submits report of nominees to Secretary.

July 31 (on or before):

Secretary sends out letter ballots for officers.

July 31 (on or before):

President appoints three tellers of election.

September (first Tuesday):

Polls close at noon.

September 15 (on or before):

Tellers certify results of election to Board of Trustees.

Secretary notifies newly elected officers and directors.

Autumn—usually during October:

Annual Meeting.

Insignia

30. The insignia of the Association shall consist of an emblem having at its topmost part the American eagle with wings spread, below which shall be a shield upon which shall be superimposed in the center a flaming bomb with the letters "U" and "S" on either side thereof. Above the bomb shall be enscrolled the words "The Army Ordnance Association." Insignia in this form with ribbon and such modifications of it in the form of pins, badges, buttons and rings shall be authorized by the Board of Trustees for use of members. The ribbon shall be the traditional Ordnance colors, the center portion being scarlet bordered with yellow and edged with black.

The President announced that the Army Ordnance Association, an unincorporated association, had transferred, assigned and conveyed all of its property to this corporation and association conditioned upon this corporation assuming all its debts, obligations and liabilities and presented a bill of sale.

On motion duly made, seconded and carried, it was unanimously

Resolved that this corporation and association accept the transfer and assignment to it of all the property of the Army Ordnance Association, an unincorporated association; and thereby expressly, in consideration therefor, assumes all of its debts, obligations and liabilities, and that said bill of sale be spread at length on the minutes. (Here follows a bill of sale.)

William C. Spruance then nominated and proposed for membership in this corporation all persons and organizations who are now members in good standing of said unincorporated Army Ordnance Association, such memberships to be in classes created or recognized by the constitution of this corporation corresponding to those in which such persons and organizations were members in said unincorporated association, and such nominations were each and all duly seconded by Henry P. Erwin.

On motion duly made, seconded and unanimously carried it was

Voted that the Secretary be and he hereby is directed to cast one ballot for all of the persons so nominated for membership.

The Secretary thereupon cast such ballot and reported that he had done so and that all the persons nominated had been duly elected and had become members of the Association.

On motion duly made and seconded and there being no further business the meeting adjourned.

(Signed) Chas. R. Baxter,
Executive Secretary.

THE Directors of the Army Ordnance Association thereupon were called in meeting and proceeded as follows:

There were present:

Benedict Crowell, President
William W. Coleman, Vice-President
William C. Spruance, Vice-President
James L. Walsh, Director
John C. Jones, Director

and by invitation: John Ross Delafield, Counsel, and Chas. R. Baxter, Executive Secretary.

The President called the meeting to order and proceeded to the transaction of business as follows:

On motion duly made and seconded it was unanimously

Resolved, that in the discretion of the President endowments shall be accepted by the Association for the furtherance of its objects and purposes.

On motion duly made and seconded it was unanimously

Resolved, that James L. Walsh of New York, N. Y., a Director of the Association, is hereby elected to membership on the Board of Trustees of the Army Ordnance Association in accordance with Article IV, Section 4, of the Constitution of said Association, for a term to expire December 31, 1930.

On motion duly made and seconded it was unanimously

Resolved, that all Committees existing in the unincorporated Army Ordnance Association and the members thereof are hereby appointed and ratified as operative in this Association, their functions to be the same as those in the unincorporated Association.

On motion duly made and seconded it was unanimously

Resolved, that the Eleventh Annual Meeting of the Army Ordnance Association be held, subject to the approval of the Secretary of War, at the Aberdeen Proving Ground, Md., during October, 1929, the exact date to be determined by the President, and that the American Iron and Steel Institute and the National Metal Trades Association be invited to participate therein.

On motion duly made and seconded the following resolution was unanimously adopted:

Whereas there is now before the Judiciary Committee of the United States House of Representatives a Bill—H. R. 15713—known as the Cramton Bill, to establish uniform requirements affecting Government contracts,

Resolved, that the Army Ordnance Association by its Officers and Directors urges the enactment of said bill into law for the facilitation of the National Defense. Be it further

Resolved that the Secretary be directed to notify the Chairman of the said Judiciary Committee of this action and to publish this endorsement in Army Ordnance.

There being no further business and on motion duly made and seconded the meeting adjourned.

Production of Artillery Ammunition

The Mission of Frankford Arsenal in Peace and War

By H. U. Wagner*

THERE are at Frankford Arsenal, three manufacturing departments: the Small Arms Ammunition Department, the Instrument Department and the Artillery Ammunition Department. Before the World War, Frankford Arsenal was the principal producer of the current annual requirements of artillery ammunition for the Army. Except for the manufacture of explosives and powders, and the loading of propellant charges for separate-loading ammunition, the Artillery Ammunition Department carried out all phases of the work involved in the production of complete rounds of field gun ammunition from the making of the forging to the loading and assembling of the complete round.

Shell Shop, Frankford Arsenal, Machining 5-inch Navy Shell.

The World War brought on a decided increase in requirements for high explosive loaded shell. Frankford Arsenal is situated comparatively close to a thickly populated district of the City of Philadelphia. The size of the arsenal is not sufficient to permit quantity loading of high explosive being carried out at any part thereof which would be sufficiently removed to assure absolute safety to the surrounding inhabited community. After the war the loading of high explosive shell as well as the loading of all other artillery ammunition components was transferred to the Picatinny Arsenal, near Dover, N. J., the location of which is much more suitable for such activities. So at the present time the production of the Artillery Ammunition Department is limited to the metal parts of shell, shrapnel cartridge cases, primers, adapters and boosters, complete round containers and bombs.

The following shops comprise the facilities of the department: Shell machining, cartridge case, fuze, sheet metal, plating, forge and heat treating and tool.

Located in the shell shops are machines and equipment for the machining of common steel shell and shrapnel for calibers from 75-mm. to 240-mm., inclusive. The shops are housed in four buildings. At the present time the shops in only two of these buildings are active, the other two being in reserve. Of the two active shops, one machines shell and shrapnel of calibers from 75-mm. to 105-mm., inclusive, and the other, shell of calibers from 155-mm. to 240-mm., inclusive. For the past two years the facilities of the latter have been largely employed in the manufacture of shell for the Navy Department.

In the reserve shops there are available for manufacturing operations approximately 75,000 square feet of floor space while the active shops contain approximately 40,000 square feet. Engine and turret lathes form the greater part of the equipment of these shops.

An entire building, with floor space of about 30,000 square feet, is devoted to the manufacture of cartridge cases for artillery ammunition. The equipment of the cartridge case shop consists principally of the large presses required in the drawing of cartridge cases; annealing furnaces; and the machines for turning and trimming the cases. The presses in this shop are all mechanical power presses manufactured by both the Toledo Machine and Tool Company and the E. W. Bliss Company.

As a matter of fact, the shops which are designated as the fuze shops do not manufacture fuzes in time of peace. The shops are housed in two buildings. One shop is inactive, being held in reserve for the emergency production of fuzes. The other is engaged, during peace time, in the manufacture of 37-mm. shell, adapters, primer parts, bomb parts, and the threading of booster casings. Before and during the World War the now inactive fuze shop produced large quantities of fuzes, including both time and detonating types. A number of machines, however, for this work have been transferred to Picatinny Arsenal, where, in time of peace, the metal parts of fuzes are manufactured.

Automatic and hand screw machines are the principal items of equipment of the reserve fuze shop. Automatic and hand screw machines and drill presses are the principal items of the active shop. The building housing the former contains about 73,000 square feet of floor space and that for the latter 12,500 square feet.

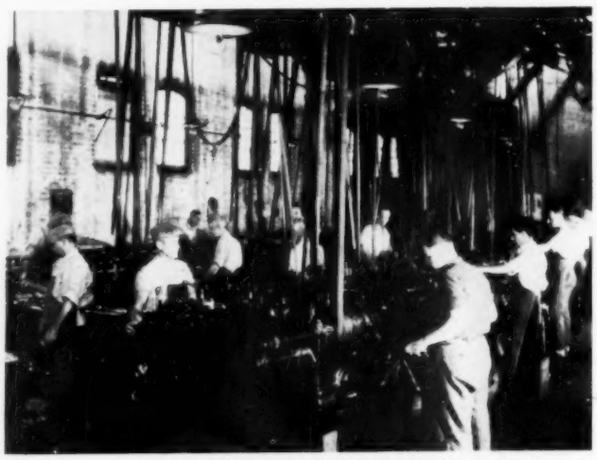
The sheet metal shop is equipped to manufacture tin and terneplate containers for complete rounds and components of ammunition and also the drawn parts of primers, booster

*In charge of artillery ammunition war plans, Frankford Arsenal, Philadelphia, Pa. Captain, Ordnance Department, U. S. A.

Cartridge Case Shop, Frankford Arsenal.

casings, and fuze seat liners. The equipment of the shop consists principally of metal cutting and forming machines for the manufacture of containers; and medium size and small mechanical power presses for the drawing of primers and booster casings. The shop covers an area of about 11,000 square feet.

The facilities of the plating shop comprise equipment for the pickling, rinsing and washing of cartridge case, booster and primer cups, as well as equipment for chromium and zinc plating. After annealing the cups in the different draws during the manufacture of cartridge cases, boosters and primers, they are pickled and washed in this shop. The installation for chromium plating is comparatively new, and includes equipment for plating pistol, rifle and small gun barrels.



Fuze Shop, Frankford Arsenal.

The furnaces and quenching tanks used in the heat treatment of shell and shrapnel are located in the forging and heat-treating shop. The shop is contained in one building with 52,000 square feet of floor space. Equipment for the nosing of projectiles, consisting of the heating furnaces and nosing hammers, is also located in this shop. The present facilities for forging projectiles here have never been operated on a production basis. The completion of the installation of the facilities was not accomplished until after the war and the requirements since that time for projectile forgings have been so small that it would not have been economical to operate this shop. The shop is equipped with facilities for nicking and breaking billets; billet heating furnaces for 75-mm., 155-mm. and 240-mm. slugs, and three units of hydraulic presses consisting of two presses each; one unit for forging 75-mm. shell, one for forging 155-mm. shell and one for forging 240-mm. shell.

The tool shop of the Artillery Ammunition Department is equipped with the usual tool-room facilities, such as lathes, milling machines, planers, grinders, etc., to manufacture the ordinary tools, jigs and fixtures required in the manufacture of the metal parts of artillery ammunition.

TAKING into consideration the facilities referred to above, it is the mission of Frankford Arsenal, in peace time, to—(1) prepare detailed plans for operation and production in time of an emergency; (2) maintain in standby condition the reserve facilities so that they can be brought into production in the event of an emergency in the minimum length of time; (3) manufacture economically the metal parts of shell, shrapnel, bombs, cartridge cases, tin containers, and primers in such quantities as may be demanded by the current consumption of ammunition by the Army; (4) manufacture the metal parts for service test lots of newly developed types of ammunition; (5) develop the method of manufacture of new types of metal parts, and improve the methods on existing types; (6) train personnel in the manufacture of ammunition; (7) prepare descriptions of manufacture, establish and compile manufacturing data; (8) compute the requirements of components of ammunition necessary to balance the stocks of ammunition components on hand and recommend allocation of production in order to meet these requirements.

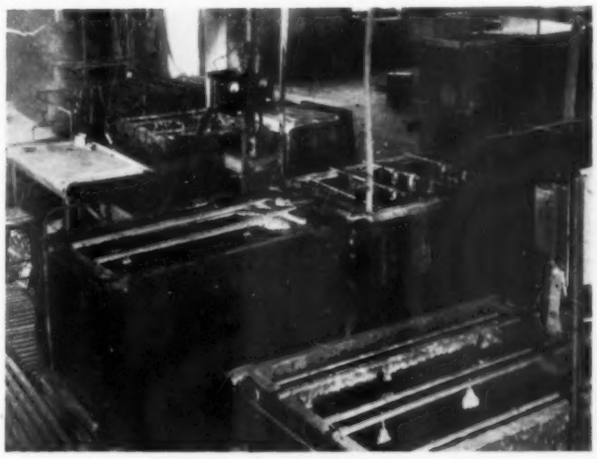
The orders for ammunition components allocated to Frankford Arsenal for production in time of an emergency form the basis for the preparation of detailed plans covering emergency operation. The requirements on this basis for all machines, jigs, fixtures, tools and gages, for personnel and equipment, and for raw materials and power, must be determined and plans made for the procurement of that which is not at present available. The drawings of all fixtures, tools and gages must be prepared, together with operations, sheets and organization charts. The plans must be complete and kept up to date.

The manufacturing facilities of the Artillery Ammunition Department would, in the event of an emergency, be called upon to bear the brunt of the production of the most

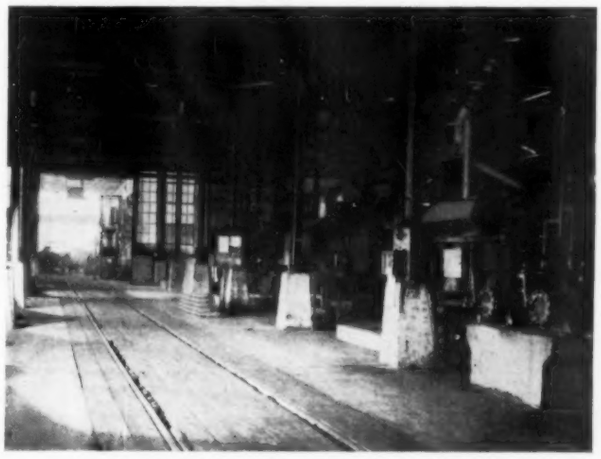
Sheet Metal Shop, Frankford Arsenal.

urgently needed components of artillery ammunition. In time of peace it is essential that the reserve or inactive facilities be maintained in first-class condition and improved wherever practicable. The important requirement concerning these facilities is that in an emergency they be able to get into production with the minimum delay.

SINCE the World War manufacture of metal parts of artillery ammunition and bombs for current consumption and reserve has been limited and has involved, to a large extent, the modification of components on hand and the utilization of partially completed components. Except for the manufacture of the metal parts of the larger bombs and of fuzes practically all of the production has been carried out at Frankford Arsenal. The orders have, in general, been numerous and small covering a large variety of different components. The production has required the use of a large variety of different special tools, fixtures, jigs and gages, a number of which were on hand and available for use. It has, therefore, been much more economical to satisfy the requirements of the Army for such ammunition components than would have been the case had it been necessary to carry this production on in commercial plants.



Plating Shop, Frankford Arsenal.

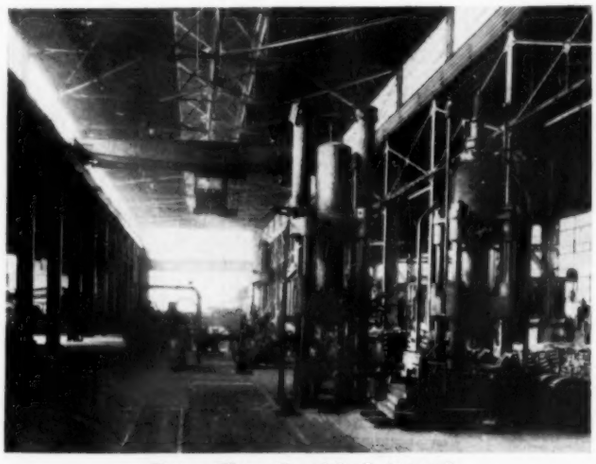


Heat Treating Shop, Frankford Arsenal.

It is required that Frankford Arsenal maintain its shops and organization so as to be able to produce the Army's current requirements for finished components in all cases except where the magnitude or character of any particular requirement would, in fairness to the Government and the manufacturer, justify the production of such requirements in commercial plants.

After a component has passed through the developmental stages, it is necessary to manufacture it in lots ranging from 1,000 to 5,000 so that the item may be turned over to the using service of the Army and thoroughly tested. In the case of the metal parts of ammunition, it is the mission of Frankford Arsenal to manufacture these lots, taking the component from the laboratory stage of production to the semiplant stage.

For newly developed metal parts of artillery ammunition, Frankford Arsenal is required to manufacture the original designs and to develop this manufacture. It is also necessary that contact be maintained with the newest and latest developments in equipment and manufacturing methods applicable to the production of artillery ammunition, so as to improve wherever possible the present methods of the production of standard items.



Forge Shop, Frankford Arsenal.

THE training of personnel in the manufacture of ammunition is a very important function of the arsenal. It is not contemplated that the personnel trained will necessarily be with the arsenal in the event of an emergency. On the other hand, it is anticipated that at such time a considerable portion thereof will find their way into large commercial plants engaged in munitions production for the Government and thus carry to these plants valuable knowledge and assistance.

In response to a demand made by the District Ordnance Offices for manufacturing information, the Ordnance Department has directed Frankford Arsenal to prepare descriptions of manufacture covering the metal parts of artillery ammunition. The demand for manufacturing information has originated primarily with manufacturers who have never previously produced munitions and who have been approached by the district representatives to assist in the work of procurement planning. In the preparation at Frankford Arsenal of the descriptions of manufacture of artillery ammunition components every effort is being made to make the data as complete as possible.

The manufacturing data available from the World War,

together with the experience of the arsenal in manufacture since the war are being used as the basis for the work. The Ordnance Department believes that the information furnished will not only materially assist a manufacturer in planning, but will also aid in cutting down the time which will be required for him to get into production in the event of an emergency. The following information is included: 1. The Ordnance Department drawings of the component. 2. A list showing the Ordnance Department number and the name of all drawings and specifications applicable in the manufacture of the component. 3. A list of operations specifying the type of machine required, the approximate horse power, the number of operators per machine, the estimated production per machine, the name and drawing number of tools, jigs, fixtures and gages applicable to the operation, and a sketch showing the component at the end of the operation. 4. A description of the contractor's inspection. 5. A description of the Government inspection. 6. A bill of raw material entering into the manufacture. 7. A diagrammatic shop layout. 8. A list of principal machines and personnel required. 9. The working drawings of all tools, jigs, fixtures and gages required in the manufacture.

CONCERNING the phase of this work which deals with shell machining and shell forging, the Assistant Chief of Ordnance has appointed a committee designated as the Subcommittee on Shell Forging and Shell Machining. This committee consists of the following members: Lt. Col. Alten S. Miller, Vice-President, Bartlett Hayward Co., 1607 Pershing Square Bldg., New York, N. Y.; Lt. Col. G. P. McNiff, Assistant to Vice-President, National Tube Company, 1609 Beechwood Blvd., Pittsburgh, Pa.; Maj. C. F. Morley, President, Morley Machinery Corp., 1139 University Avenue, Rochester, N. Y.; Mr. O. W. Buenting, General Manager of Works, Westinghouse Air Brake Co., Wilmerding, Pa.; Mr. John P. Sykes, Senior Vice-President, Baldwin Locomotive Works, Eddystone, Pa.; Mr. J. D. Cartin, General Manager, New York Air Brake Co., Watertown, N. Y.; Mr. W. C. Dickerman, Vice-President, American Car and Foundry Co., 30 Church Street, New York, N. Y.; Mr. E. H. Steedman, President, Curtis Manufacturing Co., St. Louis, Mo.; Mr. George C. Brainard, President, General Fire Proofing Co., Youngstown, Ohio; Mr. W. R. Tyson, William Wharton, Jr., Co., Easton, Pa.

Upon completion of a description of manufacture on shell machining or forging prepared at this arsenal, it is submitted for comments and criticism to the members of this committee. As a result of these comments and criticisms the original data are changed and resubmitted. Upon the approval thereof by the committee, the descriptions of manufacture are ready to be made available to the District Ordnance Offices.

As has been previously stated, the methods of manufacture set forth in the descriptions of manufacture are based upon those employed during the World War by commercial manufacturers and also upon the experience of Frankford Arsenal since the war. The designs of tools, fixtures and gages are the same or similar to those which have given good results in quantity production either during or since the war. So far as the descriptions of manufacture already prepared, covering shell machining, are concerned the sequences of operations have been carefully reviewed by the members of the subcommittee and they have strongly recommended that commercial manufacturers, in planning and also in the event of emergency production, follow the sequence of operations prescribed and not digress therefrom without first obtaining the authorization therefor from the Ordnance Department.

Descriptions of manufacture covering the following have been prepared and made available for distribution during the last year: Machining 75-mm. Mark IV shell from forgings; machining 155-mm. Mark I and Mark III shell from forgings; manufacture of the metal parts of the 110-grain primer; manufacture of Mark III, Type B, booster casings; machining 3-inch antiaircraft shell from forgings; machining 75-mm. Mark I shrapnel.

Excepting the last two items, all of the above are complete with working drawings of tools, fixtures and process gages. These for the last two are now under preparation.

THERE is in storage at the present time in the Ordnance Depots throughout the United States a considerable quantity of unloaded metal components for artillery ammunition. In the event of an emergency and until such time as commercial manufacturers can get into production upon ammunition components, it will be necessary to utilize these components in the loading and assembling of complete rounds to satisfy early requirements. To do this, each shell must have a booster, fuze, primer, booster charge, explosive charge, propelling charge and cartridge case or bag.

With respect to the assembling of the components on hand into complete rounds, the stocks are unbalanced. In some instances there are on hand more boosters, for example, than are required for the number of shell on hand, whereas the number of primers, for example, on hand may be less than that required. Generally speaking, from a production viewpoint, the finish-machined shell requires the greatest time and is chosen as the item against which the other components are reckoned.

To plan for the utilization of components on hand in the event of an emergency, the Ordnance Department has directed Frankford Arsenal to study the quantities thereof on hand, and in each caliber and type to select that component the manufacturing of which entails the greatest difficulty and time and determine the number of the various other components entering into the complete round which would have to be manufactured to assemble complete rounds of ammunition.

IN time of an emergency it is to be expected that considerable time will be required for commercial manufacturers to line up their facilities and material and start producing artillery ammunition components. In the meantime there will be requirements from the Army which every effort must be made to satisfy. The components which will be required to balance stocks on hand will be needed very early. The prime mission of Frankford Arsenal in war will be to get into maximum production with the least possible delay and manufacture the items of ammunition which are most urgently required. The arsenal must also then be in a position to render maximum assistance to commercial manufacturers, by furnishing them with manufacturing information and demonstrating various manufacturing operations and processes wherein difficulties are likely to occur.

Status of Army and Navy Ordnance

Annual Reports on Our Military and Naval Establishments

AS IS customary in these pages there are published herewith extracts from the annual reports of the Chiefs of the Ordnance Department of the Army and of the Bureau of Ordnance of the Navy for the fiscal year 1928. Both present comprehensive resumés of the activities and accomplishments for the past year.

Portions of the report of Maj. Gen. C. C. Williams, Chief of the Ordnance Department of the Army, follow:

NO material changes were made in the courses at the Ordnance School during the year. The course for Field Service work at the Ordnance School and at the Rock Island Arsenal was extended from nine to ten weeks. It is believed to afford most valuable training for the younger officers of the Department. A course in business administration was given during the past year by one of the faculty of the Harvard Graduate School of Business Administration. This course is considered to be exceedingly valuable for officers who will, at some time, be assigned to duty at the arsenals or depots, or in connection with industrial mobilization.

One officer was detailed at the plant of the Caterpillar Tractor Company, San Leandro, California. Three officers were detailed to study production engineering with various commercial plants. This is considered most valuable training for officers whose services will be utilized in connection with procurement planning or with manufacturing. This is the first year such action has been taken; the results are considered so promising that it is contemplated continuing this arrangement during the next fiscal year.

Two officers of the Ordnance Department were enrolled in the regular two-year course at the Harvard Graduate School of Business Administration; two graduated with the class in June, 1928.

Units of the Reserve Officers' Training Corps were maintained at the following institutions: Cornell University, Georgia School of Technology, Massachusetts Institute of Technology, University of California, University of Cincinnati, University of Michigan, Leland-Stanford University, and Lehigh University. The total enrollment in the advanced course was 340. Existing limitations on enrollment had a serious effect on several Ordnance units. If it were possible to remove this limitation, many additional students could be trained as reserve officers without any additional expense for overhead.

During the year 253 Ordnance Reserve Officers were trained at various Ordnance establishments. Every effort is being made to train each reserve officer for the duties which he will be required to perform in the event of mobilization. Each officer first receives a basic course which is applicable to all officers of the Department, and thereafter the special training which is required for his probable assignment.

DURING the past year much progress has been made in the procurement plans for re-armament with the latest type weapons in case of a major emergency. Under the direction of the Assistant Secretary of War, great progress has been made in the readjustment of production schedules to the civilian industrial plants through the agency of the procurement districts.

The development of studies and plans for the supply of critical raw materials in time of war has been very considerable during the past year. The progress in procurement planning, with a limited personnel, is considered very satisfactory.

The interest of civilian industrial organizations in the problem of industrial preparedness is constantly apparent. There has recently been organized a committee of civilian experts to advise the Department in connection with type plans for ammunition production. The advantage of such an organization and its value to the Ordnance Department can not be overestimated.

The Department actively initiated during the past year the preparation of type plans for the manufacture of ordnance matériel, and substantial progress has been made. These plans will undoubtedly prove of considerable value to industrial facilities in the preparation of their factory plans for emergency production.

THE following data relate to experimental and development work and manufacture of new matériel:

The development of a pistol-grip stock for the service rifle has culminated in the approval of a type known as the modified type "C," which appears to be satisfactory to all using services. The development of receiver sights has continued, and types are now under test by the Infantry and Cavalry.

The development, for test, of the semiautomatic rifle to arm the individual soldier has been actively continued. A number of caliber .276 rifles have been supplied to the Infantry and Cavalry, and have been tested by these services with favorable results.

A caliber .30 aircraft machine gun of new design, to be used interchangeably as synchronized or flexible gun, has been completed and tested by the Air Corps.

Considerable investigative work has been devoted to the improvement of the functioning of the caliber .50 antiaircraft machine gun. Other developments have continued actively during the year, notably among these being an improved type of buffer.

A new type of tripod mount, standardized during the preceding year, has been procured in some quantity, in order to supply current needs. A pedestal mount, to carry four caliber .50 antiaircraft machine guns, is being designed and is expected to be placed in production shortly. This design embodies, as nearly as may be, the changes which tests during the antiaircraft exercises at the Aberdeen Proving Ground during the fall of 1927 indicated as desirable.

Types of pack equipment for the 37-mm. infantry matériel, M1916, have been tested by the Infantry, with favorable results, and are now undergoing test by the Cavalry.

The manufacture, both by the Frankford Arsenal and

by commercial concerns, of caliber .30 ball ammunition M1, to replace the M1906 ammunition, has been continued. Frankford Arsenal has been kept running at approximate capacity on an economical peace-time basis of 66,000,000 rounds of caliber .30 ball M1 ammunition per year for Army, Navy, and Marine Corps orders, besides large orders for caliber .45 ball, caliber .30 tracer, and other ammunition for war reserve requirements.

The 75-mm. pack howitzer has been standardized, after a service test extending through the summer of 1927. Three additional pack howitzers, are nearing completion at the Rock Island Arsenal. The drawings of this matériel have been traced and put in permanent form for future manufacture under the ten-year program. Orders for matériel carried on this program will be placed early in the fiscal year 1929.

In order to check the manufacturing drawings of division artillery matériel, an order for one 75-mm. gun carriage M1 was placed with the Rock Island Arsenal. This carriage is nearing completion. A battery of four units of the 75-mm. matériel has been under test at Fort Sill, Oklahoma.

As a result of the test of the 75-mm. gun carriage M1925E at Fort Bragg, final decision has been reached in favor of the split-trail type for the division gun carriage. This type of mount permits wide traverse, and facilitates the use of this matériel against moving targets.

One battery of 105-mm. howitzer matériel has been tested at Fort Bragg, and the 105-mm. howitzer matériel T2 has been standardized.

The 155-mm. gun carriage 1920, which mounts interchangeably either the 155-mm. gun or the 8-inch howitzer, has been modified as recommended by the Field Artillery Board; it is being retained by the Board for further tests. As a result of service tests, studies of a new unit of this type of matériel will be inaugurated.

Four units of the 75-mm. mortar matériel M1922E, were completed; four additional units are nearing completion at the Rock Island Arsenal. This will make ten units available for test by the using service during the fiscal year 1929. The matériel has been standardized.

A number of sets of improved binoculars and monoculars have been completed at the Frankford Arsenal, and will be submitted to the various service boards for test. A supply of commercial glasses will be purchased and also submitted for test.

Pursuing further the development of the light mobile antiaircraft gun mount laid down by the Caliber Board, a 3-inch antiaircraft gun mount T1 and gun T1 have been designed and manufactured. Tests were conducted at the Aberdeen Proving Ground, as a result of which the gun and mount were approved as standard for manufacture. Three new guns and mounts, designated M1, embodying slight modifications, are under manufacture and will be given further tests.

The instrument trailer T1 which was manufactured last year and tested during the antiaircraft exercises, will be subjected to further tests.

As a result of the satisfactory performance obtained in the firing of the 3-inch antiaircraft gun mount M1918 by Case III at the Aberdeen Proving Ground, a number of these mounts in service will be equipped as soon as practicable with Vickers azimuth elevation, fuze-setter receivers, and continuous fuze setters.

DESIGN and development of tanks during the year has been limited principally to the medium tank T1, the light chassis T1 and the light tank T1E1, with cargo carrier based on the design of the latter chassis. The pilot chassis was completed early in the year and tested at the Aberdeen Proving Ground. Four light tanks and two cargo carriers (for Infantry and Cavalry) have been manufactured, and are now at Fort Leonard Wood for test in connection with the operation of the mechanized force. The new medium tank T1 was completed during the year and tested by the Ordnance Department at the Aberdeen Proving Ground, and by the Infantry (Tanks) at Fort Leonard Wood.

Designs for light and medium armored cars have been completed, and two pilots of the light type and four of the medium type will be manufactured for test in the mechanized force at Fort Leonard Wood.

The development of vehicles for tractor-drawn cross-country cargo transport has been confined to two distinct types of carriers. These designs are based largely on information obtained in tests of the earlier type of limber and wagon type cargo carriers. Pilot vehicles of the newer designs are being manufactured. A test of a cargo cart as a single axle 1½-ton transport vehicle indicated that this vehicle, originally intended to carry ¾-ton, is satisfactory for transporting 1½ tons at tractor speeds.

The 3-inch field gun trailer M1918, with suitable tires, body, ramps, and other accessory equipment necessary for the transportation of tractors of the light or medium class has been standardized as a tractor transport trailer. A design of ramp for use with this trailer was completed and one set of ramps was built and tested. Minor changes indicated as desirable during the test have been made and the drawings revised.

The development of the dynamometer equipment at the Aberdeen Proving Ground has been completed as far as available funds would permit. This equipment has been used in routine test work during the year. Much valuable data have been compiled, giving information concerning the pull required to move loads of practically all varieties common to military work with present matériel, operating on a wide variety of grades, etc.

The work of the oil laboratory at the Aberdeen Proving Ground has resulted in the completion of a tentative specification for the procurement of lubricants to be used in Ordnance Department automotive equipment. Lubricants procured under this specification have been used in vehicles under test during the year with entirely satisfactory results.

A partial list has been prepared and furnished to the Quartermaster General, for use in procuring lubricants for these vehicles. Work is progressing on tests to determine what additional lubricants are suitable for inclusion in this list. Additional satisfactory lubricants are being added to the approved list as the tests are completed. Tests to develop a satisfactory specification for recoil oil are in progress.

A mechanical time fuze, for use in the 3-inch antiaircraft gun, has been standardized, and manufacture of this fuze is being inaugurated at the Frankford Arsenal. Two types of combination super-quick and short-delay point detonating fuzes have been tested with very promising results.

In collaboration with the Air Corps, the design of a landing flare, known as the T1, was laid down, and orders have been given for the manufacture of five for test at the

Aberdeen Proving Ground, preliminary to the manufacture of a larger number for test by the Air Corps. This landing flare appears to be a decided improvement over the present standard M3 flare.

A projector for propelling signals for use by ground troops, and signals for the same, were supplied to the Infantry and Cavalry for service tests, the results appear satisfactory. Further tests, on a more extensive scale will be made.

Satisfactory progress has been made in the development and installation at the Picatinny Arsenal of new apparatus for the handling of TNT in the loading of ammunition. A mechanical arrangement has been installed for stirring the liquid TNT during the process of cooling to the temperature at which it is poured into the ammunition. This will supersede the previous expensive and unhealthy method of manual stirring.

Prior to the fiscal year 1928 a flashless, nonhygroscopic, smokeless powder was approved as standard for service use in the 75-mm. gun, model 1897, and a nonhygroscopic type was approved as standard for the 155-mm. G. P. F. gun, model 1918. During the past year satisfactory flashless, nonhygroscopic powders of similar type have been developed for the 2.95-inch mountain gun, the 75-mm. pack howitzer, and the 105-mm. howitzer.

WORK has continued at the Aberdeen Proving Ground with the camera obscura in determining the flight characteristics and probable error of new types and of existing types of bombs. This information is being furnished the Air Corps for use in connection with the graduation of bomb sights and for consideration in bombing tactics.

An instrument for measuring the time of flight of projectiles in connection with the test of fuzes has been constructed, based upon a combination of photo-electric cell and Aberdeen chronograph and the necessary amplifiers. The cell is acted upon by the flash of the gun, followed by the flash of the bursting projectile, this action producing records on the Aberdeen chronograph.

REAR ADM. WILLIAM C. LEAHY reports* as follows for the Navy:

During the year there were under instruction three ordnance postgraduate classes, consisting of 8, 9, and 18 officers, respectively.

Funds were appropriated for the fiscal year 1928 as follows:

Act of March 2, 1927:	
Ordnance and ordnance stores	$11,450,000
Purchase and manufacture of smokeless powder	1,000,000
Torpedoes and appliances	450,000
Experiments	190,000
Civilian employees of the bureau	144,000
Increase of the Navy (armor, armament, and ammunition)	9,500,000
Act of December 22, 1927:	
Allotted from major alterations to naval vessels (*Oklahoma* and *Nevada*)	2,123,000
Total	$24,857,000

* * * * *

*The Editors have taken the liberty of extracting such portions of Admiral Leahy's report, as in their opinion, are of general interest. Deleted parts (indicated thus * * * *) for the most part refer to matters of administration.

REPORTS from the fleet of experiences with new 5-inch 25-caliber antiaircraft guns and mounts have been used to remedy certain minor defects which developed in use afloat.

Modernization of the *Oklahoma* and *Nevada* is well under way, and 5-inch 25-caliber antiaircraft batteries have been ordered for these ships and the *California*. A 5-inch 25-caliber antiaircraft battery for the *Tennessee* has been completed and shipped.

A study of shell seating and exhaustive loading tests in the fleet and at the naval proving ground has resulted in the adoption of a new shell-seating slope for the 14-inch 50-caliber replacement battery of the *California*.

Contracts for gun forgings for light cruisers, Nos. 29, 30, and 31, have been placed at a price materially smaller than for previous deliveries of the same material.

Work on both old and new designs of gun mounts, and modification of existing mounts, is progressing satisfactorily. No armor was manufactured during the fiscal year.

In connection with the ballistic test of special treatment steel plating for light cruisers 29 to 31, for the *Oklahoma* and *Nevada*, and for triple mounts for light cruisers 29 to 31, tests have been made in coöperation with the Bureau of Construction and Repair of various types of riveting, armor hatches, and welding. Tests designed to determine the splinter protection afforded by various thicknesses of special-treatment steel when attacked by fragments of 4, 5, or 6-inch projectiles have been concluded at the naval proving ground and much valuable information obtained therefrom.

Experiments to determine the plate limits for special-treatment steel, class A and class B armor, 5 inches or less in thickness, remain uncompleted at the end of the year. These experiments when concluded will provide useful information as to the desirability of a revision of existing specifications for the 8-inch common projectiles.

A small amount of bullet-proof steel was during the year obtained for use in airplanes employed in active service in Nicaragua.

As a result of experiments with 5-inch combination antiaircraft common projectiles, this type of projectile has been adopted as standard for the 5-inch 25-caliber gun. This will eliminate the necessity for carrying two types of projectiles on board ship for the same gun.

Ballistic computations for the 5-inch 25-caliber antiaircraft fire-control instruments have been completed and 5 range tables were constructed during the year, 1 for the 3-inch mountain gun, 3 for the 8-inch 55-caliber gun, and 1 for the 14-inch 45-caliber large-chambered gun.

Single and twin antiaircraft machine gun mounts for the 50-caliber gun have been under modification and test during the entire year. Single mounts are ready for experimental installation on five destroyers. The twin mounts require further modification and test before issuing to the service for experimental installation. Sextuple mounts for 30-caliber guns have had many minor modifications and will be ready in the near future for a service test on the *Lexington*.

Thirty-caliber single machine guns on scarf ring mounts were during the year installed in the tops of two battleships, and favorable reports of the performance and value of this installation have caused the bureau to arrange for a

single installation during the ensuing fiscal year on five more battleships of the Battle Fleet.

The improvement of existing machine-gun defense against aircraft is under intensive investigation by study and experiment.

* * * * *

DURING the year the naval powder factory has operated at a daily output of about 10,000 pounds of smokeless powder which gave a total output of 3,000,000 pounds. Only a small quantity was purchased from outside manufacturers at a price slightly less than the total cost of manufacture at the powder factory. It is considered necessary to preparedness to keep the existing commercial manufacturers of naval powder sufficiently interested to insure their being prepared to expand to war-time production in an emergency. All small-arms ammunition obtained during the year was purchased from the Army. In order to utilize old stocks the practice of reworking, reblending, and reassigning old powders has been continued and has resulted in a considerable saving. A shortage in the amount of powder required by departmental instructions for all guns caused by the fire at Lake Denmark in July, 1926, has not been reduced. Funds available during the current year for the purchase and manufacture of powder were insufficient to meet the target-practice and routine test-firing requirements.

Ammunition assemblies made during the war are reaching an age that will necessitate their being broken down for examination and overhaul of the components. This work has been undertaken on a small scale and will increase during the succeeding years.

The procurement of ammunition details has been satisfactory during the year, except in the case of time fuzes. The Army, however, expects to manufacture powder-train fuzes and will within a year or two be able to handle the Navy's peace-time and war-time requirements.

The airplane flare has been redesigned and improved, but it is not yet satisfactory, and an improved flare is under design.

Because of an accumulation of ammunition and explosives at the end of the World War, ammunition storage in all naval magazines is congested.

Congress in the second deficiency act, fiscal year 1928, provided funds for the improvement of ammunition storage facilities to meet recommendations made by a joint Army and Navy board in House Document No. 199, Seventieth Congress; and authorized the establishment and development of a naval ammunition depot in the vicinity of Hawthorne, Nev. Much improvement in the existing storage conditions of naval ammunition depots can not be accomplished until the naval depot at Hawthorne is ready to receive the high explosive that now occupies space at the magazines.

Work on the depot at Hawthorne and on the other magazines for which funds are available should be prosecuted vigorously.

The yearly target practices require 1,200 tons (net weight) of powder and 4,400 tons of projectiles for the whole Navy. The larger part of this is required by the Battle Fleet in the Pacific Ocean. In addition to this, there is required for target practices an additional tonnage made up of smokeless powder packing boxes, cartridge cases, tanks, primers, and small-arms ammunition; and for other than target practice there are required shipments for new construction, and shipments for reconditioning, testing and redistributing ordnance material. It is hoped that additional facilities for shipment of ammunition will be made available.

The U. S. S. *Nitro* has been the principal means of transportation of ammunition between the coasts and between depots on each coast. At each trip the *Nitro* has been loaded to capacity and in order to meet immediate needs of the fleet it has been necessary to assign priorities to shipments.

During the fiscal year 1928, a modernized fire-control installation on the *New York* has been completed and successfully tested afloat. Fire-control installation has been completed on the *Lexington* and *Saratoga* and has been successfully tested afloat on the *Lexington*. Manufacture of matériel for the *Salt Lake City* and *Pensacola* is well under way and contract has been placed for modernized fire-control installations for the *Oklahoma* and *Nevada*.

A new and complete antiaircraft-control system installed on three battleships has functioned very successfully during the year's gun practices, and contracts have been placed for similar equipment for other ships.

Satisfactory progress in the production and improvement of mines and mine devices has been made.

A NEW type of bomb sight has been placed in production and is now undergoing tests which have been highly satisfactory to date. The replacement of wooden bomb crates by metal crates has progressed during the year. It is intended that all bombs on board ship shall be stowed in metal crates with the purpose of reducing fire risk and saving weight. The Naval Research Laboratory has completed designs for a modification of gun cameras which are being produced by the Naval Gun Factory at the rate of 25 cameras every three months.

The Naval Research Laboratory has also designed a new gun camera intended for use with the fixed gun, and in tests completed to date it has functioned properly during the most violent aerobatics and the highest speeds of which the airplane was capable.

A high-speed machine gun target sleeve has been designed which may be towed at any speed of which a fighting plane is capable when in level flight, and targets of this type were issued to the service after the completion of flight tests.

* * * * *

During the year data have been obtained which show definitely the effect of unseated projectiles and bore constrictions upon dispersion. Knowledge of these effects, which are believed to be the two greatest causes of dispersion, will aid materially in determining other causes, and the proving ground will continue an intensive study of all sources of dispersion, concentrating effort on those guns which in the fleet fail to attain the desired standard of excellence.

* * * * *

The production of illuminating projectiles has met the needs of the fleet. Experiments toward the development of a successful pyrotechnic signal were continued and preliminary tests were initiated toward the further development and improvement of illuminating projectiles. A larger and more efficient parachute and a more efficient release mechanism were developed.

Left—Human Ammunition.

A well known German cycle champion provides Hollanders with a thrill by being shot from a giant Leinart cannon. Ten pounds of powder are used and the "live" shell is hurled from the gun a height of 96 feet and a distance of 146 feet.

Right—A Coast Defense Gun?

Not at all—only a giant chimney 200 feet in height and containing a quarter million bricks which, having outlived its usefulness in the Kent coalfields, England, is razed with a charge of dynamite.

Left—"Shooting" a Thriller.

This intrepid movie cameraman risked his life to get an unusual "shot" of a tank in battle maneuvers. The tank is shown going over the operator and his camera.

ARMY ORDNANCE

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Month by Month

The New Light Tank

Anent the Army's new light tank, said Mr. Robbins, the Assistant Secretary of War, to the gentlemen of the Appropriations Committee of the House of Representatives, official representatives of "we, the people": "The light tank was tested by the Infantry, Cavalry, and the Ordnance Department; it was approved by the Infantry and by the Cavalry. The Ordnance Department tested it and recently completed a 2,000 mile run with one of these tanks, then I saw it disassembled after it had run more than 2,000 miles which is more than a tank would be required to run in any single campaign. It showed some wear on certain sprocket wheels—the wheels over which the caterpillar treads passed. They are now correcting that. They had no reason to correct the main design at all. No piece of mechanism can be absolutely perfect, but it is the best thing, and I think it is acknowledged to be the best thing we have, and it represents the difference between a tank made 10 years ago and one made today with all the improvements that have been made in internal combustion engines and motorization since the war.

"Mechanization is the idea and this is the first mechanized unit of an entirely mechanized force. It is the most essential unit of all."

Said Mr. Davis, the Secretary of War, to the same gentlemen on the same subject:

"There is the question of tanks. We have been working for several years on the improvement and the development of tanks over the World War tank. I think we have got something that is very good. It has proved very satisfactory in the tests, that is, the few that we have. It is quite a fast tank and has had comparatively few breakdowns.

"I think it is a pretty sound tank on which to standardize for the present. We are going to continue the experimental work as far as we can and get something better all the time. But I do think we have to have a modern type of tank on hand, even though we can, in two or three years, develop something a little bit better. In other words, if you wait until you get something better all the time, you will never have anything. The theory I have always gone on in all of that work is to standardize something, and when you have an article that is satisfactory, not to change it until you get another article that is a marked step in advance. Your standardized equipment is still better than the war-time stuff. I think that this tank is probably better than the tanks of any other nation.

"I think it is standardized so far as we can see in the immediate future enough to get a certain number of them. At the same time we can carry on experiments until we get something that is a marked step in advance. I do not believe we will get to that step very soon."

Query: In view of such opinion why not standardize the new light tank and proceed to the manufacture of those required to equip the Regular Army and civilian components, including the National Guard?

Answer: We, the people, are too much interested in drawing on the national exchequer for other things—fads and fancies included. And yet if mobilization day comes again the poor old Army will have to stand the gaff and we the people will only snicker when some fearless "militarist" refers to recommendations made in 1929.

McFarland's Ordnance and Gunnery

The appearance of a new text on Ordnance and Gunnery is an event worthy of more than passing notice. This is so not only because of the importance of the subject and the rarity of dissertations of this nature but because the author of the latest treatise is so exceptionally well qualified to have assumed the task. Lieut. Col. Earl McFarland, Professor of Ordnance and Gunnery at the U. S. Military Academy at West Point, is one of the most versatile and best equipped officers available for the undertaking. A man of deep knowledge, he brings to the older texts a wealth of perspective and experience. The excellence of the work of his predecessors has made the present task all the more difficult.

As to the intrinsic merits of the present work, we refer readers to the excellent review by an erstwhile editor of this Journal which appears elsewhere in these pages. To Colonel McFarland we extend heartiest congratulations upon the successful completion of a monumental task. We welcome and recommend his work to all who are interested in an authentic and complete discussion of the myriad of difficult subjects embraced in the title. To write a book is in itself a serious undertaking, but to bring forth a text on ordnance and gunnery is quite an added accomplishment, the author of which is due the praise and thanks of all friends of the national defense.

Reserve Officer Training

The schedules of spring and summer training for Ordnance Reserve Officers of the Branch Assignment Group recently announced for the current calendar year offer ample opportunity for wide and intensive training. According to the announcement, training courses will be conducted from May 12 to May 25 at the Benicia (Calif.), Frankford (Pa.), Picatinny (N. J.), Springfield (Mass.), Watertown (Mass.), and Watervliet (N. Y.) arsenals. These courses will be particularly appropriate for officers assigned to the respective arsenals and to those assigned to the various district offices whose duties require a knowledge of the manufacture or inspection of matériel.

Summer training, including both the basic and advanced courses, will be given at the Rock Island Arsenal from July 7th to 20th and at the Aberdeen Proving Ground from July 28th to August 10th. The basic course will be the same as that which has been given in past years and will be applicable to all officers regardless of assignment. The advanced course will be applicable only to officers assigned to these establishments and to those who require special knowledge which can be best imparted to them at either of these places. In general no officer who has not completed either the basic course or an R. O. T. C. training camp at the Proving Ground will be recommended for advanced training at Rock Island or at Aberdeen, and no officer will be ordered to take the basic course a second time.

This program has many attractive features. The spring courses offer an opportunity to those who cannot well leave their business pursuits at other periods of the year, while the summer camps suggest the possibility of combining the usual vacation with 14 days of active Army duty.

Reserve Officers who are willing to make some sacrifice of personal accommodation will find the several courses of interest and value. It is to be hoped that the powers that be will be flooded with applications and that those same powers will look with favor upon every possible applicant so that the year 1929 may find the roster of student ordnance officers in number and in kind of even more imposing proportions than the growing attendance of past years.

Educational Orders

THE case for educational orders for munitions never before has received the forceful presentation of the facts of the matter until the recent hearings before the Committee on Military Affairs of the U. S. House of Representatives. Sponsored by industrial executives who know from experience the complications of production in war, the facts were presented so clearly and so convincingly as to challenge the best intentioned objector. The statements established two facts quite definitely: the entire scheme is not a money-making one and without some such plan the whole idea of industrial preparedness is simply a paper program with little value as a true and tried doctrine.

As to the first fact, while not new to those who understand the plan, nevertheless the statement is something of a bombshell to those who look upon munitionment as a hobby of the "war lords." It is no such thing. It does not take an analysis by a skilled production engineer to convince the layman that the manufacture of one or two guns or of several hundred projectile offer little opportunity for great profit. Furthermore, there are no "war lords" in America. At least we have not run across them.

As to the necessity of such an expedient to make industrial preparedness something more than a paper program, it is sufficient, we believe, to say that interest in any kind of planning, even if it be a small boy's toy campaign with toy soldiers, will decline unless the small boy—and the grown-up too—actually can maneuver his men and put them through the paces. Vociferous statesmen (?) can rant as they will and they can decline, if for illogical reasons they see fit, to authorize this practical defense measure, but the facts remain the same. The pity is the national defense must suffer. Elsewhere in this issue we begin the publication of a series of statements by experienced industrialists on the logic of the plan. These are worthy of the widest publicity in the hope that the people themselves will know the facts and demand appropriate remedies.

Association Affairs

WE believe that all members of the Army Ordnance Association should take considerable interest in the transactions of the Board of Directors at their annual meeting in January as recorded elsewhere in this JOURNAL. Notable among the business transacted was the incorporation of the organization under the laws of the District of Columbia thus giving it a legal status. The Association has been in existence nearly ten years during which time the worthiness of its objects has been demonstrated and the need of such a vehicle has been proved. Incorporation has many advantages. The Association in number of members and in financial standing is now in better condition than ever before and it is fitting that this advantageous step be taken that the important work may continue.

Among the other noteworthy actions of the Board are those relating to endowments and life memberships. The endowment idea is not new. It has been and is the salvation of many worth while movements and has a very definite place in the future of the Army Ordnance Association. Notwithstanding the present healthy condition of the organization it is but reasonable to assume that as the World War recedes in memory interest in its lessons will dwindle. The day will come eventually when those of us who learned by bitter experience the principles we now call industrial preparedness will have passed from the stage of active participation and will have journeyed to that bourn from which no traveler returns. As the ranks thin the problem of recruits will become increasingly difficult—and naturally so. The rising generation will lack the perspective, the experience, the close contact with the chaos of an industrially unprepared America. Then will come the pinch and the struggle to carry on. But carry on we must. Consequently the action of the board in encouraging a foundation through endowments is a most happy and indeed an apparently vital one. Having proved its value during ten years of peace the Association now puts in operation the machinery for perpetuating the work so that those who come after us may be spared a repetition of one of the calamities of the World War.

The newly authorized plan for life membership has similar advantages. While relieving members of the bother of paying dues annually, life membership will likewise assure the organization a larger and more definite "rainy day" fund for present and future needs. Sums received for life membership will be invested in sound securities, the interest thereon being applied as membership dues during the life of the member. Endowments will be treated similarly except that the principal sum always will remain intact for the purposes for which it is given. Already negotiations are under way for the first gift to the endowment fund, while several life members have been enrolled. Certainly there is every indication that the organization, after ten years of missionary work, now launches on a permanent undertaking to assure for America of today and tomorrow the blessings that must come to a nation industrially prepared for war as the surest guarantee and a most effective expedient of continued and lasting peace.

Old Friends and New at The Helm

An Editorial

THE nones of March in this year of grace brought changes aplenty in affairs of national defense. The century old succession of commanders-in-chief of Army and Navy has taken place: Calvin Coolidge, of Vermont, taciturn yet tenacious administrator, giving place to Herbert Hoover, of California, engineer, humanitarian and citizen of the world. In Ex-President Coolidge the common defense found a sympathetic friend and at times a zealous champion; in President Hoover, judging by past performance, vision, action and determination will be no less forceful.

Dwight F. Davis, of Missouri, who relinquishes the reins of Secretary of War, retires from his high office with the unanimous feeling among military and civilan confrerés that his was a task well done in every respect. His departure from office, although a thing to which one should be accustomed in national affairs, accentuates the great accomplishment of his service and the high value of his administration.

Charles Burton Robbins, of Iowa, the Assistant Secretary of War, who likewise retires to private life, gave to industrial preparedness and to munitions supply matters a high and forceful purpose. His departure marks the passing of a competent and able leader.

The new cabinet presents in the portfolio of War James W. Good, of Iowa, lawyer, legislator and administrator of worthy proportions. As chairman of the powerful Committee on Appropriations of the U. S. House of Representatives following the World War, Secretary Good had ample opportunity to become familiar with the requirements of the Army. Pressing needs have developed since concerning which there is every indication that the new Secretary will bring to Army affairs—men and munitions—a valuable experience and sympathetic understanding.

Patrick J. Hurley, of Oklahoma, lawyer and World War veteran, is the new Assistant Secretary, while F. Trubee Davison, able Assistant Secretary for Aviation, remains to continue the excellent work he started several years ago which has already produced such far-reaching results.

We of the Army Ordnance Association should take particular pride in the appointment of two other members of President Hoover's cabinet. Henry L. Stimson, former Secretary of War and now Secretary of State, served as counsel of the Association until recently. Of broad international experience and with a record of meritorious military service, he has served his country conspicuously and assumes the affairs of state with the benediction of many, not the least of whom are those of his compatriots in the Association.

Our own Robert P. Lamont, one of the founders, a charter member and a director of the Association since its organization, merits the high honor of Secretary of Commerce. During the World War he served as chief of the Procurement Division in the Office of the Chief of Ordnance. The magnitude of that task and the high proficiency with which he performed it, together with his prominence in industrial affairs, bespeak a period of service to American commerce to rival the record of his illustrious predecessor. It may be said with righteous pride that the national defense has devoted friends at court.

NOTWITHSTANDING all this, the retirement of Secretary Davis is a fitting occasion for speaking one's mind freely on the merit of his service. Mr. Davis, who be it remembered won his laurels during the World War, came to the War Department first as Assistant Secretary in 1923, becoming Secretary in 1925. After eminent public service to his native city, St. Louis, he assumed one of the most difficult undertakings in Government affairs. Industrial preparedness, the particular problem of the Assistant Secretary under the National Defense Act, was as yet a somewhat visionary mandate. Only the mere outline of its functions had been attempted; no one had had a real opportunity to develop it. Secretary Davis did that, and, thanks to his energy and foresight, the vast coöperative machinery we have today is the result.

One of the most constructive achievements of his tenure was the establishment of the Army Industrial College, that unique institution founded to envelope the Army officer with the cloak of business sense that the problems of preparedness may be solved by business-trained Army officers coöperating with business men. We envision the day when, thanks to the pioneer work of Mr. Davis, the Army Industrial College, as yet an infant as institutions of learning go, will take its place with the great service schools in acknowledged importance and in plant where, in Davis Hall, the precepts of business will be taught student officers of the Army in the setting of a West Point, a Leavenworth, or a War College.

UNDER his guidance decentralized planning and procurement again became an actuality. The supply branches of the Army during the World War, concentrated in the National Capital, bidding against one another for materials, succeeded in out-Gordianing the Gordian knot of centralization. The remedy was not forthcoming until the vision and determination of the late Guy E. Tripp, then an assistant to the Chief of Ordnance, untangled the mass and established the Ordnance District organization, dividing the country into territorial divisions with headquarters in strategic industrial centers under the leadership of civilian chiefs. The necessity and the wisdom of the move during the war need no argument; the results are well known. But with the swing of the pendulum after the war the permanence of such an organization in times of peace to prevent the very recurrence of a similar debacle in another emergency was seriously jeopardized as the back-to-normalcy drive swept good and bad before it. To Secretary Davis belongs the credit for reëstablishing the decentralized system which is in effect today virtually as it was at the end of the war. That system is the very backbone of industrial preparedness.

Other defense matters of great importance but not so patently within the strict purpose of this JOURNAL received the undivided and best thought of Secretary Davis. These we leave to other commentators to record. But be it said in all sincerity that with the retirement of Mr. Davis there steps from the helm of military affairs a man who gave to the new science of defense the life blood it needed. His name takes its place among that long line of Secretaries of War who have done great things for the Nation.

Books

Spy and Counter-Spy, The Development of Modern Espionage. By Richard Wilmer Rowan. New York: The Viking Press. 1928. $3.50.

THE study of the mysterious phase of warfare involved in the activities of the espionage systems is nearly always alluring. This is decidedly true of Mr. Rowan's book which describes the intricacies of the profession of the spy in a thorough manner, and yet with a wealth of anecdote that constantly urges the reader on. In the first part of his book, dealing with espionage, we are told what the functions of the intelligence officer and the spy are, how the spy goes about his labors and how he communicates the results of his observations. The second part describing counter-espionage and the third the activities of the most successful and best known secret agents are equally effective in making this a painstaking study of the subject, readable and authoritative.

The Radio Manual. By George E. Sterling. New York: D. Van Nostrand Co. 1928. $6.00.

THIS is the most complete manual concerning the details of commercial transmitting and receiving systems which has come to our notice. It "has been prepared to serve as a guide and text-book to those who expect to enter the radio profession as an engineer, inspector, commercial or amateur operator" and seems admirable for this purpose. The elements of electricity and magnetism are treated of sufficiently to enable the reader to understand the explanations of radio phenomena which are given, regardless of whether or not he has studied these subjects previously.

The amateur will find in this volume information concerning the regulations governing the procurement of operators licenses and the operation of radio stations. The more advanced operator or engineer will appreciate those parts concerned with the more complicated apparatus employed at land and ship stations for purposes of communication and of aiding navigation. The works of authorities in the field of science and radio engineering have been consulted and often quoted in the preparation of the text, which has been edited by Robert S. Kruse, the result being a wholly acceptable handbook on the relatively new and rapidly advancing science of radio in its varied applications to human endeavor.

We Fight for Oil. By Ludwell Denny. New York: Alfred A. Knopf. 1928. $3.00.

THE theme of this excellent work on the status of petroleum oils in modern civilization emphasizes President Coolidge's statement, "It is even probable that the supremacy of nations may be determined by the possession of available petroleum and its products." This is quoted on the title page.

Quoting chapter and verse in most cases to substantiate his statements, Mr. Denny tells in a very interesting and readable way about the struggle between Great Britain and the United States for world supremacy in oil. The close relation between commerce and international politics is clearly brought out. Perhaps most striking is that while we lead in oil production the British Empire leads in the possession of reserve oil lands. The author is a newspaperman with first-hand knowledge of his subject. Now that national defense is being assailed in Congress is an opportune time for this important book to appear, for it shows the power, the ramification and the subtleness of the forces opposing our country.

Vibration Problems in Engineering. By Prof. S. Timoshenko. New York: D. Van Nostrand Co. 1928. $4.50.

THE author in this volume develops the fundamentals of the theory of vibrations, first in its more simple forms and later in its more complex aspects, and shows the application of the ideas evolved to the solution of the class of problems from actual experience with which it is designed to cope. The need for a thorough analysis and knowledge of the causes of vibrations in mechanisms and the proper means for reducing or eliminating them becomes more and more important with the rapidly increasing trend to use more massive high speed mechanisms and the demand for more perfect passenger automobiles and high speed heavy trucks and busses.

The first chapter is concerned with harmonic vibrations of systems having one degree of freedom and the second chapter with nonharmonic vibrations of similar systems. In the third chapter are considered systems having several degrees of freedom. The vibration of elastic bodies is discussed in the fourth chapter.

The theories involved are developed clearly and logically in the usual clear and concise style of Prof. Timoshenko and should not be difficult of application to practical engineering problems. An appendix explains some of the more frequently used vibration measuring instruments. Numerous footnotes indicate the agreement of other investigators with the views expressed in the text and constitute a bibliography of pertinent collateral reading.

Manufacturing. By Malcolm Keir. A volume of Industries of America. Malcolm Keir, Editor. New York: The Ronald Press Co. 1929. $5.00.

AN interesting and readable book on manufacturing seems rather an impossible achievement. Without diminishing its value to the technical reader, the author has succeeded in accomplishing this, however, writing a clear and illuminating treatise on manufacturing, descriptive and untheoretical, that amply repays careful study. "Manufacturing" is the first volume of a series of publications entitled "Industries of America," which has great promise judging from the book under consideration.

Professor Keir approaches each subject by providing an historical perspective and emphasizes the relation of one type of manufacture to another. The entire field is comprehensively treated. We would single out for especial praise the chapters on iron and steel, and the automotive

Just Published

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industry, but the work as a whole is well written and valuable to the student, the manufacturer, or the layman, who would understand the material basis of our civilization.

Rasputin, The Holy Devil. By René Fulap-Miller. Translated from the German by F. S. Flint and D. F. Tait. New York: The Viking Press. 1928. $5.00.

ANY account of events in Russia leading up to the World War and of events that transpired at the Imperial Court during the War invariably refers to the influence of Rasputin on the conduct of affairs.

Who was this man? What was his origin and early training? Was he devil or divine? Why was he able to exercise such control over the Tsar and Tsaritsa? Was he a grafter or benefactor? These questions are answered fully in this book. The facts are derived from official records of the old and new Russia.

Rasputin was neither altogether a libertine nor a saint. He was a man of rich nature and exuberant vitality, endowed with many good qualities and cursed with many weaknesses; a man so many sided, complex, and contradictory that a further study of his life is fascinating.

This book traces the life of Rasputin from his childhood on the farm through his young manhood as a teamster, as a religious wanderer through Russia, as a cellar preacher and finally as a friend and adviser of the royal family. A good portion of the book is devoted to Rasputin's activities at the Imperial Court and his dealings with officials of the government. His murder is described as a brutal act of thrill seekers.

The translation has been ably done and the book is profusely illustrated with copies of official photographs.

Analysis of Railroad Securities—A Guide to the Determination of Investment Values. By Jules I. Bogen, Ph. D. New York: The Ronald Press Co. 1928. $4.25.

PREPARATION of a volume of this nature for the guidance of security analysts and investors is more than justified by the wide ownership in this country of railroad securities. By means of clearly explained and readily understood methods of analysis Mr. Bogen facilitates the estimate of the value of an individual road. This he accomplishes by a consideration of the territory served, the physical characteristics of the road and equipment, the quantity and quality of the traffic, and finally through an investigation of operating efficiency. There is a thorough study of methods of financial analysis of earnings statements. A comprehensive treatment of the question of valuation and consolidation gives the reader a useful knowledge of these controversial subjects. A discussion of railroad bonds as investments and of the characteristics of railroad stocks offer some novel points of view in this field. This book—by an assistant professor of finance at New York University—provides a valuable and reliable manual on the subject covered.

Without Censor—New Light on Our Greatest World War Battles. By Thomas M. Johnson. Indianapolis: The Bobbs Merrill Co. 1928. $5.00.

THIS is a purely military history. It leaves out of account for the most part the concurrent conditions, political and economic, which made possible the achievement of the armed forces at the front. But in the field to which it is confined it is a most valuable contribution, and is

welcome as one of the first unbiased accounts of American participation on the Western Front, especially at St. Mihiel and in the Meuse-Argonne. The author has obviously gone to primary sources. His style is interesting and he is impartial in his estimates of leaders and the value of the participation of the various allied forces in the final months of the war. The book sheds new light on the strategy proposed and the reasons for the plans ultimately adopted.

The Stream of History. By Geoffrey Parsons. New York: Charles Scribner's Sons. 1928. $5.00.

TO Leibnitz is attributed the statement that the more knowledge advances the greater the possibility of condensing it into little books. This task of condensing the entire past of the earth into a volume of less than six hundred pages has been admirably conceived and brilliantly executed. The continuity of history is emphasized despite the dark periods which temporarily halted progress. Mr. Parsons states his purpose "to tell the whole story of man and his earth and to tell it so swiftly and simply that its essential parts will stand forth in their due relationships unobscured by detail." The result is a praiseworthy and unprejudiced treatment of the fundamentals of the geologic history of the earth, of the coming of life and ultimately man, of the stone ages, the rise and fall of the early and later civilizations, bringing the story down to the world today. There have been other universal histories. In its comprehensiveness, its balance, and readability this work of Mr. Parsons has no equal.

A College Grammar. By Mason Long, Associate Professor of English Literature, The Pennsylvania State College. New York: The Ronald Press Co. 1928. $3.00.

YOU remember Monsieur Jourdain, the parvenu in the "Bourgeois Gentilhomme," who made a fortune and then decided to make good the omissions of his early education. To his astonishment, he learned from his philosophy teacher that he had been speaking prose all his life without knowing it. Professor Long believes that by giving thought to our prose in time, we can speak and write more effectively. Judging from the slovenly English too often heard from our presumably educated, the melancholy fact must be accepted that a book such as this is necessary. Admitting the need for it, the author has presented a useful and original analysis of this subject of English grammar in novel and attractive form. It is intended not only as a college textbook, but as a "manual of accepted contemporary usage."

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Introduction to Theoretical Physics. By Leigh Page, Ph. D. New York: D. Van Nostrand Co. 1928. $6.50.

DR. PAGE has prepared this book as a text for advanced students specializing in physics, the basis therefor being a lecture course given by the author at Yale. A knowledge of calculus and differential equations is, as might readily be assumed, a prerequisite for its use. In the introduction is developed a sufficient survey of vector analysis as to permit its use and thus eliminate some of the more burdensome algebraic detail which would otherwise be necessary. The book covers the whole field of modern theoretical physics in five parts; which are, dynamics, hydrodynamics, thermodynamics, electromagnetism and optics and spectroscopy. The theories expounded are developed in such detail as to be followed and understood readily, and, in order that the principles enumerated may be made thoroughly clear, numerous illustrative problems are given.

Conquest: America's Painless Imperialism. By John Carter. New York: Harcourt, Brace & Co. 1928. $2.50.

THE author has, as in his previous book, "Man is War," produced an excellent and authoritative work on an important modern topic presented in a most interesting and readable style.

Particularly striking is the comparison Mr. Carter draws between the political form of the British Empire (and of previous empires) and the financial and commercial form of America's empire. He shows with remarkable but reliable figures the enormous extent of America's world power (we have nearly half the world's wealth); a situation realized by few people in our country.

Recognizing the likelihood of a new world war due to international trade, the author shows how we must be *strong* to enforce the peace which is essential to the expansion of our economic empire. Special stress is laid on the necessity for divorcing our economic foreign empire from politics in foreign countries in order to allay the enmity which our power is already causing. Mr. Carter sees our best field for future commercial expansion as North, Central and South America, and after that westward to the lands washed by the Pacific. This brief review cannot do full justice to this important book, which is recommended to all interested in the foreign relations and the future prosperity of our country.

The Handwriting on the Wall, A Chemist's Interpretation. By Arthur D. Little, Ch. D. Boston: Little, Brown & Company. 1928. $2.50.

A WELL known chemist looks at modern industry and makes clear the contribution of his profession to present-day technology. In this collection of essays, Dr. Little's initial thesis is the importance and essentiality of research, if progress is to be maintained. He discusses the proper utilization of our natural resources from the point of view of the chemist. He shows the vast importance of chemistry to the nation in arms in a chapter entitled "The Sinews of War," most interesting to readers of Army Ordnance.

In conclusion he looks to the future, and in the final chapters he offers constructive suggestions for the elimination of waste and the upbuilding of our resources, and discusses the duties of men of science to their country in this period of transition. Dr. Little has written an inspiring book in a lucid style which will appeal to a very wide class of readers.